THE

Tea Research Institute

OF

Ceylon.

BULLETIN No. 10.

Annual Report for the Year 1932.

Published by

THE TEA RESEARCH INSTITUTE OF CEYLON.
VICTORIA COMMEMORATION BUILDINGS, KANDY.

IMPERIAL MYCOLOGICAL
6 JUNE 1933
INSTITUTE

The Tea Research Institute of Ceylon.

BOARD OF CONTROL.

(A) Representing the Planters' Association of Ceylon:—

(1) Mr. R. G. Coombe (Chairman),

(2) Mr. Jas. Forbes, (Jnr.),

(3) Mr. J. Horsfall.

(B) Representing the Ceylon Estates Proprietary Association:—

(4) Mr. R. D. Morrison.

(5) Major J. W. Oldfield, M.C., C.M.G., O.B.E.

(6) Mr. I. L. Cameron,

(C) Representing the Low-Country Products' Association:—

(7) Colonel T. G. W. Jayewardene, V. D.

(D) Representing the Small-Holders:—

(8) Mr. D. H. Kotalawala, M.S.C.

(E) Ex-Officio Members:—

(9) The Hon. the Financial Secretary.

(10) The Director of Agriculture.

(11) The Chairman, Planters' Association of Ceylon.

(12) Chairman, Ceylon Estates Proprietary Association.

Secretary, Mr. A. W. L. Turner, Victoria Commemoration Buildings, Kandy.

SEVENTH ANNUAL REPORT

OF THE

BOARD OF THE TEA RESEARCH INSTITUTE OF CEYLON

FOR 1932.

Foundation:—The Institute was established and the Board of Management incorporated by Ordinance No. 12 of 1925, dated the 27th October, 1925.

Past Chairmen of the Institute.

Name	Date of Appointment	Date of Resignation.
Major J. W. Oldfield, C.M.G., O.B.E., M.C.,	7th January, 1926.	24th November, 1926
John Horsfall, Esq.	24th November, 1926.	14th April, 1927
R. G. Coombe, Esq.	14th April, 1927.	9th April, 1929
Major J. W. Oldfield, C.M.G., O.B.E., M.C.,	9th April, 1929.	30th September, 1929
C. Huntley-Wilkinson, Esq.	30th September, 1929.	28th November, 1929
R. G. Coombe, Esq.	29th November, 1929.	7th April, 1932
G. K. Stewart, Esq., M.S.C.,	7th April, 1932.	26th November, 1932
R. G. Coombe, Esq.	26th November, 1932.	

Board of Management:—On the 1st January, 1932, the Board of Management consisted of the following Members:—

Ex-Officio Members.

The Hon'ble the Financial Secretary, (Sir Wilfrid Woods, C.M.G.).
The Director of Agriculture, (Dr. W. Youngman, D.Sc., Ph.D.).
The Chairman, Planters' Association of Ceylon, (Mr. A. G. Baynham).
The Chairman, C.E.P.A., (Mr. G. K. Stewart, M.S.C.),

Representatives of the Planters' Association of Ceylon.

Mr. R. G. Coombe.
Mr. John Horsfall.
Mr. C. C. du Pré Moore.

Representatives of the Ceylon Estates Proprietary Association.

Major J. W. Oldfield, C.M.G., O.B.E., M.C.
Major H. Scoble Nicholson, O.B.E.
Mr. J. A. D. Finch Noyes.

Representative of the Low-Country Products Association.

Mr. C. H. Z. Fernando.

Representative of the Small-Holders.

Mr. D. H. Kotalawala, M.S.C.

Secretary:—Mr. A. W. L. Turner.

Mr. R. G. Coombe, Chairman of the Institute, proceeded on furlough from April to November, Mr. G. K. Stewart acted as Chairman during his absence.

Mr. C. Huntley-Wilkinson acted as Representative of the Planters' Association of Ceylon during Mr. Coombe's absence.

Mr. C. H. Z. Fernando resigned on the 22nd August, and the Low-Country Products' Association appointed Col. T. G. W. Jayewardene, V.D., to fill the vacancy. Col. Jayewardene previously served on the Board from 7th January, 1926 to 31st October, 1928.

Mr. J. A. D. Finch Noyes retired from Ceylon in June, and the Ceylon Estates Proprietary Association appointed Mr. R. D. Morrison to fill the vacancy.

Major H. Scoble Nicholson, O.B.E., proceeded on furlough in June, and the Ceylon Estates Proprietary Association appointed Mr. I. L. Cameron to act for him.

Mr. Jas. Forbes (Jnr.) returned from furlough in November and relieved Mr. C. C. du Pré Moore who was acting for him.

Meetings of the Board of the T.R.I.:—The Board of Management held 4 Meetings—2 in Colombo, 1 in Kandy, and 1 at St. Coombs Estate, Talawakelle. The average attendance was 9.

Subvention to the P. A. of Ceylon:—The thanks of the Board are due to the Planters' Association of Ceylon for having reduced the subvention payable to them for office accommodation and secretarial work, from Rs. 700 to Rs. 400 per mensem.

COMMITTEES.

Experimental Sub-Committee. *Personnel*:—The Director, T. R. I., the Chairman, T. R. I., the Visiting Agent of St. Coombs, the Superintendent

of St. Coombs, Messrs. John Horsfall, C. Huntley-Wilkinson, I. L. Cameron, R. H. Horne, Jas. Forbes (Jnr.) and the Agricultural Chemist, T.R.I., (Convener).

During the absence of the Agricultural Chemist (Mr. T. Eden), the Plant Physiologist (Mr. F. R. Tubbs) acted as Convener.

This Sub-Committee met on three occasions.

Conference Sub-Committee:—This Sub-Committee was appointed on the 29th March. *Personnel*:—The Chairman, T. R. I., the Director, T. R. I., Mr. John Horsfall and Mr. F. J. Whitehead,

Finance Sub-Committee:—This Sub-Committee was appointed on the 28th July. *Personnel*:—The Chairman, T. R. I., the Chairman, Planters' Association of Ceylon, the Chairman, Ceylon Estates Proprietary Association, Major J. W. Oldfield, Messrs. R. D. Morrison and John Horsfall.

This Sub-Committee met on three occasions.

Small-holders Sub-Committee. *Personnel*:—The Director, T. R. I., the Director of Agriculture, Mr. D. H. Kotalawala, Mr. C. H. Z. Fernando and Dr. C. H. Gadd.

This Sub-Committee met on one occasion.

STAFF OF THE T. R. I.

Senior Scientific Staff:—At a meeting of the Board held on the 15th December, it was decided to renew the agreement with Dr. Roland V. Norris (Director) for a further period of four years as from the 12th August, 1933.

Mr. T. Eden (Agricultural Chemist), having returned from furlough, resumed his duties on the 10th October.

Junior Staff:—Mr. B. N. Sastri, (Research Assistant to the Biochemist) severed his connection with the Institute as from the 31st March, and it was decided to abolish this post, and appoint two Junior Assistants. Mr. E. L. Keegel was appointed on the 15th March, and Mr. P. R. Perera was appointed on the 1st April.

Mr. F. H. Kehl succeeded Mr. I. R. Nicol as Field Assistant in the Department of Physiology as from the 1st October.

Small-Holdings Officer:—Mr. R. L. Illankoon was appointed Small-holdings Officer as from the 1st October.

BUNGALOWS.

Bungalows Nos. 3 and 4 were occupied as from the 1st August.

JUNIOR STAFF PROVIDENT FUND.

The Fund has been approved under Section 9 (1) (g) of the Income Tax Ordinance.

Mr. A. G. Baynham acted as a Trustee of the Fund during the absence on furlough of Mr. Jas. Forbes (Jnr.).

Mr. E. N. Perera was appointed a Trustee by the Members of the Junior Staff to fill the vacancy created by the resignation of Mr. B. N. Sastri.

Insurance:—Provision has now been made in the rules to permit Members to utilise not more than two-thirds of the contributions made by the Institute and by themselves for the purpose of Life Insurance.

INCOME TAX ORDINANCE.

The Income Tax Ordinance came into operation on the 9th February. The Institute has been granted exemption.

EMPIRE MARKETING BOARD.

The Institute has received £961-0-9 out of the £1,000-0-0 granted for the purchase of Small Scale Machinery.

IMPERIAL ENTOMOLOGICAL & MYCOLOGICAL INSTITUTES.

As there appeared to be some possibility of the valuable connection with these Institues being lost if no contribution was forthcoming from Ceylon, the Board decided to make a donation of Rs. 750 to each of these Institute for one year.

PROPOSED AFFILIATION WITH THE U. P. A. S. I.

This subject was brought up again for consideration and it was decided that the time was not yet opportune for reopening negotiations.

MANUFACTURE.

In order to keep the Scientific Staff "au fait" with market requirements, a Conference was held in Colombo on the 14th July. There were present Representatives of Agency Firms, Buyers, Brokers, Planters, and Officers of the Senior Scientific Staff of the Institute. It is proposed to hold further Conferences as and when required.

Bulletins Nos. 7 and 9 deal very fully with Manufacturing problems.

NEW MACHINERY.

The Board hopes that when any new type of Machinery is installed on any Tea Estate, that facilities will be granted for Officers of the Institute to inspect and report thereon. If this suggestion is carried out, the results may be helpful to the estate concerned and also give the Institute useful information.

DISSEMINATION OF INFORMATION.

(1) It is intended to lease a small area to be worked directly by the Institute as a demonstration plot and also to approach Co-operative Societies with a view to assistance being afforded to Small-holders. Arrangements have already been made whereby a number of Small-holders are working their holdings under the supervision of the Small-holdings Officer.

(2) The Board hopes that District Planters' Associations will continue to invite Members of the Scientific Staff to their Meetings in order to encourage full discussion on all problems connected with tea cultivation and manufacture.

BIRD SANCTUARY AT ST. COOMBS.

Two Bird Sanctuaries have been established at St. Coombs with a view to increasing the number of insectivorous birds.

PUBLICATIONS.

The Publications of the Institute will be sent, free of charge, to Superintendents of Ceylon Tea Estates, over 10 acres in extent, and to Estate Agencies dealing with Ceylon Tea, if they register their names and addresses with the Secretary, Tea Research Institute of Ceylon, Victoria Commemoration Buildings, Kandy.

Other persons can obtain the Publications of the Institute on application to the Secretary, the subscription being Rupees fifteen per annum for persons resident in Ceylon or India, and £1-5-0 for those resident elsewhere. Single numbers of *The Tea Quarterly* can be obtained for Rs. 2-50 or 4 shillings. In the case of Indian cheques four annas should be added to cover commission.

During the year, the Institute issued Bulletins Nos. 7, 8 and 9 and *Tea Quarterly* Volume V, Parts 1-4.

The undermentioned Publications are out of print:—

Bulletins Nos. 2 and 3.
Tea Quarterly Volume I, Part 3.
,, ,, ,, II, Part 1.
,, ,, ,, IV, Parts 1 and 2.
,, ,, ,, V, Part 1.

ANNUAL REPORT OF THE T. R. I.

The Hon'ble the Minister for Agriculture and Lands has decided that a limited number of copies of the Annual Report shall be printed as a Sessional Paper at Government expense.

ST. COOMBS ESTATE.

Visiting Agent:—Mr. J. W. Ferguson.

Superintendent:—Mr. John A. Rogers.

The average gross price obtained for St. Coombs Teas during the year was 69 cts. against the Colombo Market average of 61 cts. for high grown teas. A graph illustrating the comparison between the St. Coombs prices and the Colombo Market average for high grown teas is attached herewith.

A copy of the Visiting Agent's Review on the work done on St. Coombs during the year is attached.

FINANCE.

The Audited Statement of Accounts is attached.

A. W. L. TURNER,
Secretary.

PROGRESS REPORT

ON

ST. COOMBS ESTATE

FOR THE YEAR 1932.

Superintendent:—Mr. John A. Rogers.

Climate:—Season 1932 was not unusually wet for this district, but there was a great deal of mist and a lack of sunshine.

Rainfall for 1932, 79·91 inches. No. of wet days, 218.

Rainfall for 1931, 112·79 inches. No. of wet days, 231.

Crop:—Estimated 125,000 lbs. Made Tea.
Secured 1932. 126,644 lbs. Made Tea.
Secured 1931. 113,629 lbs. Made Tea.
Increase 13,015 lbs. Made Tea.

The yield per acre was 746 lbs. on the old tea acreage.

The 1926-27, 57 acres clearing was partly pruned in April and allowed to grow well up before tipping. Three rounds of tipping leaf were thrown away. This acreage yielded 10 lbs. per acre Made Tea.

Cost of Production:—

Revenue Account, Estimated Cost 64·21 cts. Actual Cost 56·00 cts.
Capital Account, Estimated Cost 17·04 cts. Actual Cost 13·36 cts.

Manufacture:—Nett Average for 1932. 62·00 cts.
Nett Average for 1931. 94·78 cts.

Old Clearings:—57 acres were supplied during the year under review with 10,800 stumps from the St. Coombs Nurseries and are doing well. There is still a fair percentage of low jât bushes which are being removed and replanted with good jât stumps.

New Clearings (1931):—The 1931 clearing (28·75 acres) has made good progress during the past year, and was supplied in August with 4,334 stumps from the St. Coombs nurseries. The 1932 clearing (9½ acres) was opened under favourable conditions, and came away well, but rather suffered from an unusual drought in December. This drought unfortunately brought along with it a severe attack of Tortrix, which did considerable damage and may result in a high percentage of vacancies.

Nurseries:—Owing to the opening of clearings being curtailed there are some 166,000 two-year-old tea stumps in the nurseries. A certain number will be used for supplying the old tea and clearings. If no further land is to be opened in 1933 an effort will be made to sell the remaining stumps.

Green Manure:—A great deal has been done to supply this want and many of the ravines have been planted with different varieties, which will be made use of when forking is taking place.

Buildings and Machinery:—These are all in good order.

General:—In spite of the fact that expenditure had to be very much curtailed during the year, good progress has been made in bringing the old tea acreage into good order.

Credit is due to the Superintendent for the satisfactory progress.

(Sgd.) J. W. FERGUSON.

St. Clair Group,
Talawakelle,
15th February, 1933.

REPORT

OF

THE DIRECTOR,

TEA RESEARCH INSTITUTE OF CEYLON

FOR 1932.

The year under review has been one of considerable difficulty and anxiety owing to the very uncertain financial position resulting from the slump in the tea market. St. Coombs, in common with most other estates, has suffered from the decline in tea values and the nett average obtained for our teas was only 62 cents as compared with 94·79 cents for 1931. Crop, on the other hand, was slightly above the estimate, the yield being 126,644 pounds or rather more than 13,000 pounds in excess of the 1931 figure.

The fall in revenue from tea sales was partially offset by higher receipts from the tea cess, but it was necessary to make considerable cuts in expenditure, both on the estate and research sides, in order that the estimated carry-forward at the end of the year should be realised. It is satisfactory, however, to be able to state that in spite of these economies it was possible to maintain the programme of work which had been arranged for the year.

Staff:—No additions were made to the Senior Staff. Mr. Eden was on home leave until the 10th October, during which period Mr. C. A. de Silva was in sub-charge for the Agricultural Division, while field experiments were under the supervision of Mr. F. R. Tubbs.

The Junior Scientific Staff was increased by three, and numbered fifteen at the end of the year. Of these, ten were working at Headquarters, three at the Nettle Grub Laboratory in Passara, one at Galatura in the Ratnapura district and one in the Gampola area.

It is a matter for regret that the financial position has not yet permitted us to provide separate quarters for all the Junior Staff. No further increase in the Junior Staff is contemplated in the near future, for not only has the accommodation question to be solved but our recurring expenditure is now at a figure which cannot safely be increased until our general financial position is more assured.

Laboratories and Buildings:—No additions were made to the laboratories, and expenditure on equipment had to be reduced to a very low figure which it will be difficult to maintain. Two Senior Staff bungalows were completed and occupied in August by the Entomologist and the Plant Physiologist. The only other buildings constructed were two rooms in the lines for T. R. I. subordinates.

It is most unfortunate that funds have not yet been available for the construction of accommodation for visitors. Until this can be done it will be a matter of difficulty to provide facilities for short instructional courses for which there is a considerable demand. It is the definite intention of the Institute to provide such courses at the earliest possible date.

Visitors' Day:—Though a considerable number of planters and other interested persons visited St. Coombs during the year, one would like to see greater use made of the facilities provided for visitors to come to the laboratories to discuss their problems with members of the Staff. On Visitors' Day all members of the Senior Staff are at Headquarters and a visitor can, therefore, be sure of finding the appropriate officer to deal with his enquiries. It will, moreover, be realised that if visits be made on these days undue interruption in the work of the staff will be avoided.

Library:—Dr. Gadd has remained in charge of the Library which has now been placed on a proper basis in regard to classification and arrangement. In addition to books and journals obtained by purchase, a large number of periodicals and reprints of scientific papers is received in exchange for the Institute's own publications, and it has already been necessary to extend the shelving accommodation originally provided. Planters and other persons interested are, of course, at liberty to make use of the Library, though books and periodicals cannot be removed from St. Coombs.

Publications:—In addition to *The Tea Quarterly*, three Bulletins were issued during the year. The Institute's publications are issued free to all Superintendents and Assistant Superintendents of Ceylon Tea Estates over ten acres in extent and to Estate Agencies dealing with tea, provided they register their names with the Secretary of the Board. There is also an increasing demand for our publications from other persons and the income from subscriptions amounted to Rs. 3,261 in the last year.

To reduce the nett cost of publications it was decided to accept advertisements for insertion in *The Tea Quarterly*. Such advertisements at present produce about Rs. 1,800 a year.

The preparation of leaflets in the vernaculars for the use of smallholders is at present under consideration.

Advisory Work:—There was again a marked increase in the advisory work, more than 2000 enquiries being dealt with, while 245 visits were paid to estates by members of the Staff, excluding visits made by the Small-holdings Officer. The number of visits has nearly doubled as compared with 1931, a fact which clearly indicates that planters are making more and more use of the Institute. The condition of the tea industry has been reflected in the nature of the enquiries received, more than half of which related to manufacture. Enquiries relating to plant diseases, on the other hand, have diminished, chiefly, probably, because on many estates, funds have not been available for the treatment of minor diseases and attention has rather been concentrated on the maintenance of soil fertility and manufacture.

Meetings of the Dimbula, Dickoya, Dolosbage, Kandy, Matale, Nuwara Eliya, Pussellawa, Sabaragamuwa and Southern Province District Planters' Associations were attended by members of the Staff. The Director was also present at the meetings of the General Committee of the Planters' Association and of the Estate Products Sub-Committee of which he is a member.

It would be helpful if members of the staff could more frequently be present at meetings of District Associations, not simply for the purpose of giving formal lectures, though these will be arranged when required if reasonable notice be given, but even more so for the opportunities such contact would provide for informal discussions with Superintendents.

Manufacture:—As already mentioned, the condition of the tea market during the year has impressed upon most Superintendents the necessity for improving the quality of the tea turned out. Much greater attention has, therefore, been paid to manufacture which has been reflected in the large number of enquiries which have been received by the Institute on this subject. On the other hand, in some cases the impression seems to be held that with the market in its present condition, any attempt to improve manufacture is a waste of time, the price obtained bearing little relation to the intrinsic merits of the teas made. This view is quite unsound, but has undoubtedly led in not a few cases to an acceptance of coarser plucking in an endeavour to increase yields and diminish working costs.

Good prices were obtained for St. Coombs teas in the earlier part of the year but later on, with the general fall in values, emphasised by the insistant demand for coloury liquors almost regardless of other qualities, there was a very marked falling off though there was little or no evidence that the teas made were in any way inferior to those turned out in previous years. It became evident, therefore, that the system of manufacture required modification in order to try and meet market requirements during the off-season. It was, in consequence, decided that a much wider programme of

experimental work should be carried out in the factory, the commercial plant as well as the small-scale machinery being utilised for this purpose. Such a policy was clearly necessary, not only to meet our own immediate requirements, but also to obtain as rapidly as possible further information in regard to the various processes of manufacture which might be of assistance to other estates, particularly to estates in the low-country. Details of many of these experiments will be found in the Report of the Biochemist. They show that while it is not, perhaps, difficult to obtain more coloury liquor, e.g., by longer withers, it is not easy in some teas to obtain this result without some sacrifice of other desirable qualities, such as pungency and quality.

At those seasons of the year when quality and flavour are present every effort should be made to preserve these, and long withers do not seem desirable. At other times when flavour is absent it may well pay to risk some loss of pungency to obtain more coloury liquors. In short, manufacture must be modified as necessary to meet seasonal variations in the leaf and varying market requirements. In this connection a closer liaison is required between the producer and the market. If some more satisfactory basis of reporting on tea samples could be evolved it should be possible for the Superintendent to receive more implicit indications as to the intrinsic properties of his teas and some guidance as to which of these should be developed under different market conditions.

Visits to many estates have clearly indicated that in numerous cases withering is probably the determining factor in the quality of the teas made. Reference has already been made to the duration of withers, but it is obvious that equal attention must be paid to the rate at which the loss of moisture occurs during different stages of the wither.

Firing conditions have been closely studied during the year. Much greater attention is now paid to the temperature of firing but it has also to be remembered that satisfactory firing cannot be expected when there are wide fluctuations in the moisture content of the leaf coming to the machine.

There is considerable scope for improvement in drying machinery. In this connection the Institute is anxious to co-operate with engineering firms, and data as accumulated will be freely placed at their disposal.

Opportunities have been taken as available to observe the performance of new types of machinery such as the C. T. C. Roller and the Legg Cutter. Whatever may be the results obtained with these machines elsewhere, our observations of their working in Ceylon have so far failed to give any indication that they will fulfil the claims made.

The Marshall-Boustead chilled rollers on the other hand seem to have much greater promise, though further experience is required of their working under different conditions.

Two further rollers, one sifter and one drier have been added to the small-scale plant in St. Coombs Factory, the cost being met from the grant made by the Empire Marketing Board. These machines have been of the greatest use, not only for general experimental work, but for the regular manufacture of the leaf from the experimental plots, thus enabling the effect of the various treatments under investigation on the quality of the made tea to be examined. Here grateful acknowledgment must be made of the assistance so freely rendered by both Colombo and London brokers in reporting on many hundreds of experimental tea samples.

Reference has already been made to the necessity for closer contact between the producer and market interests. So far as the Institute is concerned some steps have already been taken to secure liaison by means of conferences between members of the staff and representative brokers and buyers.

Before leaving the subject of manufacture reference may be made to the investigations carried out by the Mycologist on the micro-organisms present on the leaf during manufacture. In some quarters it has been suggested that such organisms play an important and essential part in tea fermentation. The evidence in favour of this theory has never been very convincing and the present investigation lends no support to the view that they are concerned in normal fermentation. On the contrary their presence would appear to be detrimental, though where proper conditions of cleanliness are observed little trouble is to be anticipated.

Field Experiments:—The results of the second year's working of the manurial experiment at St. Coombs will be found in the Report of the Agricultural Chemist. So far as yield is concerned, potash applications have, as in the first year, shown no significant result. Nor has any significant difference been found in the response to the three different kinds of nitrogen employed—sulphate of ammonia, cyanamide and blood meal. Leaf from these plots is being manufactured on the small-scale plant in order that the influence of treatment on quality may be examined. The results of these comparisons are given in Dr. Evans' report.

The experiment is of particular interest at the present time, in so much as the substitution of inorganic artificials for the more expensive organics would enable very material economies to be effected in manuring programmes. In spite of considerable prejudice against the use of inorganic nitrogenous manures there would appear to be little risk in their employment provided green manuring is carried out as intensively as possible. On St.

Coombs in the coming year, organic artificials will not be used in the old tea and the effect of substituting inorganics will be closely watched. While on the subject of manuring, it may also be noted that it has been decided to drop the use of special pruning mixtures. One general mixture will be employed at equal intervals through the pruning cycle, the first application being made about four months after pruning.

Pruning experiments are now in full plucking at St. Coombs, Peradeniya and Galatura, and are described in the report of the Plant Physiologist. It is as yet too early to discuss yields under the different type of pruning employed, but in regard to recovery from pruning, results of great interest have already been obtained. The data clearly show the significant improvement as regards die-back which results from the use of rim lung pruning at low elevations. Rim lung pruning has the further advantage that the centre of the bush can be properly cleaned out at pruning, and these experiments strongly suggest that its use at low elevations will be highly beneficial.

The Plant Physiologist has also begun a study of different tea races, and a considerable number of strains has been collected and planted.

Methods of propagation are also receiving attention. In Formosa layering is considered worth-while in spite of its cost, and it is considered that a study of this and other methods of vegetative propagation will be of value. Even though such methods may not at present be required for estate working, the provision of uniform material for experimental purposes would be highly advantageous and enable such experiments to be carried out on a much smaller number of bushes.

Field trials both in mature tea and on a young clearing have been made by the Agricultural Chemist, of a number of green manure and cover crops. So far, *Parochetus communis* appears much the most promising of those investigated and this is being propagated for more extensive planting on St. Coombs and for distribution. Increased provision has been made in the estimates for 1933 for work on such crops and the number of varieties under trial will be materially increased.

The Mycologist is continuing his study of the nodule organisms of leguminous crops but the results are not yet sufficiently definite for discussion. Acknowledgments are due to Dr. H. G. Thornton of the Rothamsted Experimental Station and the Staff of the Bacteriological Department, Wisconsin Agricultural Experiment Station who have kindly supplied different strains of the nodule organism.

Soil Chemistry:—The absence of the Agricultural Chemist on leave has limited the amount of work under this head. Interesting data, however, will be found in his report showing the beneficial effect of sulphur in correcting soil alkalinity in nursery areas.

Plant Diseases:—These have not been unusually prevalent during the year and no new diseases have come to hand. Witches Broom remains a disturbing element as there is some evidence that this is increasing, and as the cause is still quite obscure, no satisfactory remedial measures can yet be recommended. In view of the fact that Tea Yellows, a somewhat analogous disease occurring in Nyasaland, has been shown to be due to a deficiency of sulphur in the soil, experiments have been instituted on two estates to see if this also applies to Witches Broom. No definite information can yet be given. Further details will be found in the report of the Mycologist in which particulars are also given of work in the prevention of wood rot.

Insect Pests:—Considerable progress has been made in the breeding of the Tortrix parasite, *Trichogramma*, and the work has sufficiently advanced for a field trial of this method of control to be made as soon as Tortrix reappears in sufficient numbers. Tortrix caused some inconvenience at St. Coombs where it appeared in some of the experimental blocks, but generally speaking, its incidence has been less than in the previous year.

A small sub-station with a staff of three assistants has been maintained in Passara throughout the year for work on Nettle Grub. This pest has caused much less damage than hitherto, both the number and intensity of attacks having greatly diminished. Soap sprays continue to be the best method of artificial control, the cost being about Rs. 12-50 per acre.

It is unfortunate that birds are usually scarce in tea estates owing to the lack of facilities for nesting. The encouraging of certain species of insectivorous birds might well do much to keep down insect pests, and the subject is receiving attention in St. Coombs.

Small-Holdings:—Statistics have been collected during the year in regard to small-holdings in tea and these have already been published in *The Tea Quarterly*. The total area of such holdings is about 35,000 acres, but large numbers of the individual holdings do not exceed one acre in extent. This fact renders advisory work difficult owing to the economic position of the owners. A special Small-holdings Officer was appointed in October last who is working in the Gampola-Peradeniya-Kadugannawa area. The response to his work has been striking and many small-holders are already working their lands under his guidance. Such holdings will form demonstration plots from which other holders will see that improvement can be effected in regard to soil treatment, plucking, pruning, drainage etc. without undue expense. A demonstration plot leased and run by the Institute will shortly be strated and by means of lectures, leaflets and other propaganda work, the small-holder will be encouraged in every way to improve the condition of his holding. Close touch is maintained in this work with the various village organisations and societies, and help has been freely given by the Chief and Minor Headmen of Uda-Nuwara, Uda-Palata and Kotmale.

Tea Cider:—The Mycologist has investigated the preparation of this beverage. Cultures of the necessary organism are now available and can be supplied to those interested.

Future Work:—The future development of the Institute's programme of work is entirely contingent on the financial position in the next two years. It is not to be expected that tea prices will immediately recover, and reduced receipts from tea sales must be anticipated. The imposition of a 15 per cent. restriction in tea exports will automatically reduce the income from the tea cess by about Rs. 50,000 in the current year, while in 1934 the rate at which the cess is collected is due to be reduced from 14 to 10 cents per 100 pounds tea. Moreover, it is as yet still uncertain whether the Institute will be required to restrict its own crop. Should this be necessary, the further reduction in income will undoubtedly necessitate some revision in the programme of work. Representations have been made asking for exemption of the Institute from restriction, and it is greatly to be hoped that a position will not be allowed to arise which may necessitate any curtailment of the Institute's activities and of the facilities which it can afford to planters. In this connection our thanks are due to the Planters' Association of Ceylon for the substantial reduction made in the annual contribution due from the Institute.

Acknowledgments:—In addition to acknowledgments already made, it is a pleasure to record our appreciation of the assistance and hospitality so freely accorded by Superintendents in every district. The Director of Agriculture and his staff have given every facility for the pruning work at Peradeniya and the Amalgamated Tea Estates Co. Ltd., Messrs. James Finlay & Co. and Superintendent, Galatura Estate similar assistance in connection with the experiments on that estate. We are indebted to the Chief Scientific Officer, Tocklai Experimental Station; the Director, the Tea Experimental Station, Java and His Majesty's Consul in Formosa, for their help in the collection of representative seed races. Messrs. George Steuart & Co. and the Superintendent of Gonakelle have again afforded accommodation for some of the Nettle Grub Staff. The Superintendent, Colombo Observatory has continued the loan of meteorological instruments, Mr. F. J. Whitehead has as usual given invaluable help in connection with the water supply and other engineering problems, and the Institute owes much to the Visiting Agent, Mr. J. W. Ferguson, who has given unstintingly of his time and experience in connection with experimental work on the estate.

The Reports of the Scientific Officers are appended.

ROLAND V. NORRIS,

Director.

REPORT OF THE MYCOLOGIST FOR THE YEAR 1932.

Advisory:—There has been a decrease in the number of enquiries and of specimens submitted for examination during the year, as compared with last year. This is to some extent a reflection of the financially difficult times through which estates are passing. Maintenance charges have been reduced to a minimum with the result that the treatment of minor diseases, which from experience are known to be of temporary duration and which do not create any great risk for the rest of the crop, has had to be eliminated in many cases.

330 letters were received and 306 despatched. 139 consignments of diseased plants were received; of these 119 were tea. The remainder consisted of miscellaneous green manure plants and shade trees grown on estates. Thirty four visits to estates have been made for investigational and advisory purposes in the Balangoda, Bogawantalawa, Haputale, Hewaheta, Kandapola, Kotmale, Lindula, Morawak Korale, Norwood, Pelmadulla, Pussellawa, Ratnapura and Watagoda districts.

No new disease of any importance has been recorded during the year. A further case of *Rhizoctonia solani* causing a leaf disease of tea, similar to that recorded in 1928 was observed in the Ratnapura district in January, in localized patches in one field. The disease was prominent while conditions were wet, and it is probable that the dry weather which followed greatly assisted its control.

In 1930 a species of *Aglaospora* was reported to be in association with diseased roots of *Acacia decurrens*. The same fungus has now been found on the roots of tea bushes which had been killed by lightning. In this case, there was no doubt that the fungus was in no way responsible for the death of the roots and it would appear that, at least as far as tea is concerned, the fungus is entirely saprophytic.

Witches Broom:—During the early months of the year Witches Broom became prevalent generally through the Kandapola district, but a marked recovery had occurred by the end of May. This general attack through the district appeared to be the result of adverse climatic conditions. Other cases have come under observation where fields before pruning showed markedly all the symptoms of the disease, yet after pruning the bushes recovered normally and produced healthy growth.

The symptoms in the above cases were indistinguishable from those occurring in certain fields, where the disease is steadily becoming worse with no sign even of temporary recovery. These observations support the view expressed in the last annual report that the cause of the disease is not always the same and that the symptoms which together constitute the Witches Broom disease are indicative of a derangement of the life processes of the bush, independently of the actual cause which brings about the derangement.

In view of the fact that the Yellows disease of tea in Nyasaland has symptoms which closely resemble our Witches Broom, and that the cause of Yellows has been ascertained to result from a deficiency of sulphur in the soil, an experiment was laid out to test whether a corrective treatment on these lines here would give similar beneficial results. At the time of writing no improvement in the treated plots has become evident.

The Yellows disease of Nyasaland differs in certain respects from our Witches Broom disease, particularly in the fact that the first symptoms of Yellows is a very definite and peculiar yellowing of the leaf which does not normally occur in Witches Broom. It is the secondary symptoms which so closely resemble Witches Broom. This adds support to the view that Witches Broom symptoms are the consequence of malnutrition or some interference with the normal physiological processes of the bush.

Attempts have been made to transplant affected bushes from estates where the disease persists to a plot adjacent to the laboratories at St. Coombs. Considering the horticultural difficulties entailed in transplanting sick bushes, a fair proportion of successes has been attained, and it is of interest that in some cases the bushes are showing signs of recovery. It is as yet, however, too early to be certain of this point.

Wood Rot:—It is now generally recognised that wood rot which causes unsightly rotten cankers in tea branches is the result of entry of wood rotting organisms into the wood via wounds and large pruning cuts. Preventive measures must be directed towards protecting such wounds from invasion of wood rotting organisms. Such protection may be given by painting the wound with a suitable antiseptic paint, which is not easily washed off and which will remain effective for a long period.

The failure of such treatment in the field is not always due to inefficiency of the paint. The paint must be placed on a clean surface, as, if the fungus is already within the wood, a paint on the surface, unless it is able to penetrate to the depth to which the fungus has attained, will do nothing to kill the fungus. There is, however, another cause of failure particularly where transverse, or end, cuts are treated. If the tea stems could be cut back invariably to a bud the success of wound treatment would be increased. This, however, is impossible, and when a stem is cut, it is in many cases impossible to tell exactly where new growth will arise. Should it arise at some distance below the cut, the painting of the cut is unlikely to prove an effective preventive of wood rot. The reason is that the stem standing above the point at which new growth arises is bound to die back, and it is through this dead and unprotected tissue that the wood rotting organism can enter. The majority of fungi which normally cause wood rot are incapable of gaining entry into the bush through living tissues such as the cortex. At the time the cut is made, the cut surface is the only convenient place of entry for the organism and must therefore be protected by paint. But in the course of time, an inch or more of this

stem may die back because there is no bud on it to take on new growth. The whole surface of this dead snag then forms a suitable entry for the fungus as it is protected neither by living tissue nor by paint. For such reasons a paint may incorrectly be condemned as inefficient and another tried.

The primary test of efficiency of any wood preserving paint should be its ability to prevent the entry of wood rotting organisms. Other characters are also of importance, particularly its ability to resist weathering and its harmlessness when applied to living cortex. For reasons stated above it is often difficult to determine the efficiency of a paint in the field, particularly as regards its ability to resist the entry of organisms. An inefficient paint may appear good because it is not exposed to virulent organisms; on the other hand an efficient paint may fail because the stem below the painted area has died back.

For this reason an attempt has been made to devise a laboratory test by which paints may be tested. This consists of painting blocks of wood, after soaking in water and sterilising, with various preparations, and then exposing the treated blocks to the attack of a virulent wood rotting organism. In this test the fungus *Irpex destruens* was used as the wood rotting organism.

One set of blocks painted with each disinfectant under trial was placed in running water for about two months; another was exposed to the weather for a similar period before being placed in a flask with the fungus and chips of wood on which the fungus could establish itself. The third set was inoculated as soon as the paint was dry. The percentage loss in dry weight of the treated blocks, which is a measure of the degree to which the blocks have rotted, is given in the following table:—

Per cent. loss of dry weight of wood blocks.

	After washing	After exposure to weather	After painting	Mean
Control. (untreated)	14·6	10·6	18·8	14·6
Mason's Mixture	6·3	21·5	2·9	10·2
Solignum	0·3	4·7	+0·2	1·6
Cargilineum A	+4·5	8·5	19·4	7·8
Cargilineum B	1·3	+2·7	+2·8	+1·4
Presxyl	+0·2	7·6	0·5	2·6
Tar	0·4	5·1	18·9	8·1
Washed Tar	4·9	4·5	16·4	8·6
Tar and Skene's Wax	+0·3	4·5	23·0	9·1
Candarsan	9·3	35·7	14·5	19·8
White-lead paint	+33·7	+30·0	+18·9	+27·5

(+ indicates a gain in weight).

The results of the experiment are somewhat conflicting. The best results have been obtained from White-lead paint, Cargilineum B and Solignum. The increase in weight of the blocks painted with White-lead is due entirely to the heavy nature of the paint; there was, however, no visual sign of any rot having occurred in any of the blocks and they were as sound after being in the flask with the fungus for 12 months as they were when put in.

The reason why the blocks painted with Mason's mixture should have rotted so markedly after exposure to the weather is not apparent. The weather was unduly wet, but if the disinfectant was washed out one would expect a similar effect after placing the blocks in running water. The fact remains that 3 of the 6 blocks thus painted and exposed to the weather rotted badly and could be easily torn in the hands. Candarsan is not an efficient wood preservative, yet here again exposure of the blocks to the weather before inoculation led to a marked increase in the rot which followed, the rot being more marked than in the unpainted control blocks. The reason why this should be so is obscure.

It is apparent that some improvement in the technique of the experiment is necessary before truly comparable results can be obtained. Although care was used to have the blocks uniform as regards water content at the commencement of the experiment, it was found impossible to control the water content later. This fact is of importance because the liability of a block of wood to rot is dependent to some extent upon its water content. It is possible that the smaller amount of decay which occurred in general in the blocks after being washed in running water for 2 months is due to their greater degree of saturation by water.

Micro-Organisms and Manufacture:—The micro-organisms present on tea leaves are mainly bacteria and fungi including yeasts. Counts made at different times indicate that their numbers vary considerably from time to time, but they are always present in large quantities. From a sample of withered leaf as many as 120 thousand fungi and 22 million bacteria per gramme have been counted. As 28·3 grammes = 1 ounce, one realises the enormous numbers present in a withering loft and the possibility of some playing a part either beneficially or detrimentally in the manufacturing processes. Many fermentation processes are dependent upon the activities of micro-organisms, particularly yeasts, while bacteria are well known to play important parts in decay and the destruction of food products.

It is now generally recognised that the fermentation of tea is an enzymic process which is carried on independently of the presence of living organisms. At the same time, there remains the possibility that the micro-organisms may play a small, yet important, part. It has been claimed that the yeasts materially affect the flavour and that taints are

caused by bacteria. Evidence on these points is not conclusive, so a number of experiments were carried out to throw further light on the subject.

If micro-organisms play an important part during the manufactory processes it is to be expected that their numbers would materially increase during this period. The following results per gramme of leaf were obtained from samples taken from a mass undergoing manufacture.

	Number of Fungi	Bacteria
Withered leaf. ...	55,000	21,000,000
After 1st roll. ...	6,000	7,000,000
After last roll. ...	1,000	25,000,000
After fermentation.	4,000	19,000,000

There is here no evidence of any increase in number; instead there is a very large decrease during the first roll. A decrease is difficult to account for and it is to be suspected that the method of counting may be at fault.

The method of counting is to wash a known weight of leaf in a known quantity of water and then to count the organisms in the washings. It seems probable that the organisms are more readily washed off the leaf before rolling and that the juices crushed out during rolling cause the organisms to stick to the leaf sufficiently firmly to prevent their recovery in the washings.

In order to test this hypothesis, a sample of withered leaf was thoroughly mixed, then one half of it was passed through a mincing machine. Counts made on the minced and unminced leaf gave the following results:—

	Number of Fungi	Bacteria
Before mincing. ...	52,000	11,000,000
After mincing. ...	12,000	900,000

The above figures are the averages of 9 counts each from the same sample of leaf and the differences obtained are statistically significant. The experiment proves a decrease in numbers following mincing but does not explain the cause. A possible explanation has already been offered. There is another, however, in that the juices of the tea leaf may have an antiseptic action similar to that known in the hop. Experiments have been devised to ascertain whether tea juice has an antiseptic action on various fungi and bacteria but so far no positive evidence has been obtained to show that this is the case.

If tea juice is antiseptic its action is specific and not general, because it is well known that crushed tea leaf left for some time becomes mouldy. This is also shown by the following counts made on fermenting leaf. Withered leaf was passed through a mincing machine and equal quantities placed in thermos flasks to ferment. Counts were made immediately after mincing and 5, 24 and 48 hours later.

	Number (per gramme of leaf)		
	Fungi	Yeasts	Bacteria
Before fermentation.	3,600	2,000	1,700,000
After 5 hours.	3,000	—	1,000,000
After 24 hours.	1,000	200,000	4,000,000
After 48 hours.	—	100,000,000	500,000,000

The numbers of fungi are definitely misleading. Fungi occur on the withered leaf as spores and each spore collected in the washings is counted as a fungus. When the spore germinates it gives rise to a long thread or hypha so that the number of fungi does not increase until new spores are produced. The hyphae are difficult to wash off the minced leaf with the result that there is an apparent decrease in their number yet the mass of fungus has increased. On the other hand, the growth of yeasts and bacteria is accurately represented by their numbers because their growth is concentrated on the production of new individuals which bud off or divide from the parent body, and so are more readily counted.

As one would expect, the growth of the micro-organisms is at first slow but increases rapidly with time. There is a far greater increase in numbers during the second day than during the first. From the practical point of view it is immaterial what happens after about 5 hours from the leaf leaving the withering loft, as by that time it has normally entered the firing machine. The firing of the tea stops further activities of the organisms so that if they are to play an important part in the manufacture it must take place before firing. The above figures indicate that the organisms are least active during this important period.

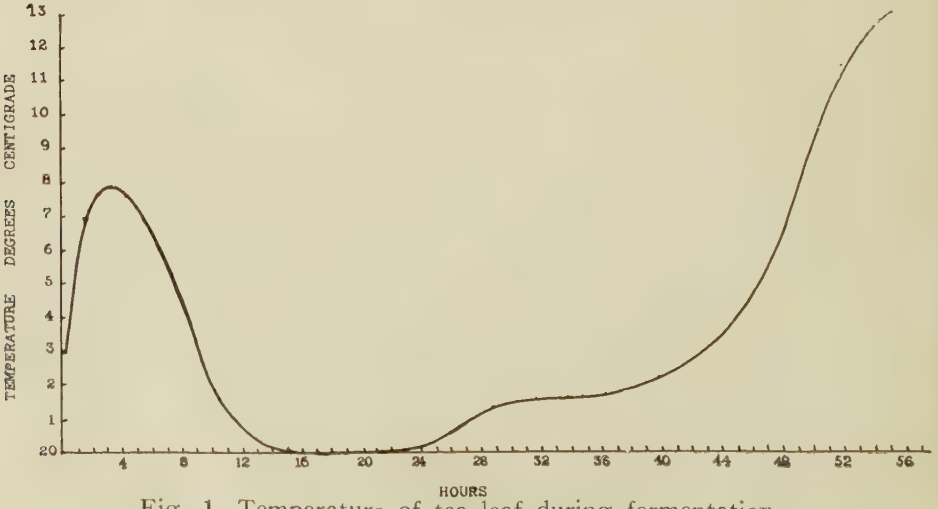


Fig. 1. Temperature of tea leaf during fermentation.

In the foregoing experiment the temperature of the fermenting leaf in the thermos flasks was recorded at frequent intervals. The resulting temperature curve, given in figure 1, is typical of others made under similar

conditions. It will be seen that there is at first a rapid rise in temperature, followed by an almost equally rapid fall. After 24 hours there is a further rise which begins slowly but increases in intensity. It is during this second rise that the micro-organisms are most active, and as will be shown later, this rise is entirely due to the heat developed by the activities of these rapidly multiplying organisms.

The first peak in the temperature curve is undoubtedly due to the normal enzymic fermentation which takes place independently of the organisms. This can be demonstrated by fermenting leaf which has previously been sterilised without injury to the leaf itself. For this purpose withered leaf was washed with a 0·5 per cent. solution of mercuric chloride for 3 minutes followed by 3 washings with sterile water to remove the disinfectant. A similar quantity of leaf was washed with 4 changes of sterile water as a control. Both lots of leaf were crushed in a fruit press and quickly rolled by hand before being placed in thermos flasks. The resulting temperature curves are given in figure 2. It will be noted that both lots of leaf gave immediate rises in temperature but that a second rise was exhibited only by that leaf which had not been sterilised. This clearly demonstrates that the first rise in temperature is not due to the activities of organisms but that the second which begins to be evident after 24 hours is caused by the micro-organisms.

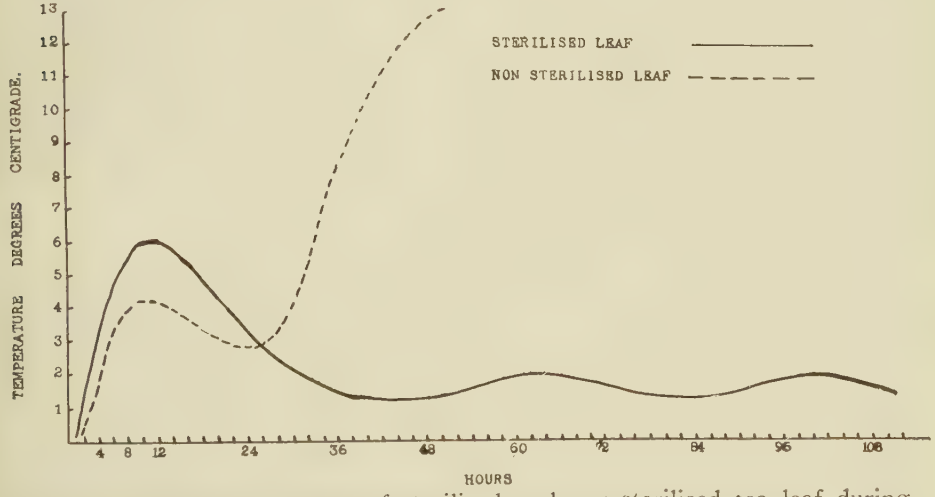


Fig. 2. Temperature curves of sterilised and non-sterilised tea leaf during fermentation.

If the leaf is sterilised with boiling water which destroys the enzyme of the leaf as well as the micro-organisms, the temperature remains constant and fluctuates only as the external temperature rises and falls.

It will be realised that tea manufactured under such conditions, i.e., washed with a disinfectant or water and fired in a laboratory oven will

not compare in quality or flavour with tea made under normal factory conditions. It may, however, be of interest to record a comparison of small samples made as above and fired after 12, and 48 hours' fermentation. A further sample made from disinfected leaf after 96 hours' fermentation was included. The better teas were those made after 12 hours' fermentation and there was not much difference between that made from disinfected and that from merely washed leaf. But there was no question between the teas fired after 48 hours. That which had not been disinfected had a foul odour and was definitely bad. The unpleasant odour and taste had not developed in the disinfected tea which had fermented for 96 hours and this tea was infinitely superior to the 48 hours non-sterilised tea.

This experiment indicates that the effect of micro-organisms is in the main detrimental and that their effect though not marked during the first 12 hours becomes very prominent within 48 hours.

In the ordinary factory manufacturing process tea is never left to ferment for 12 hours; usually fermentation is stopped after less than half this time, so there appears very little likelihood that the organisms existing on the leaf will exert any immediate detrimental effect on the manufactured tea. It must be borne in mind, however, that the bad odours and taints which arise from the action of micro-organisms do not, as a rule, originate in the organisms' bodies, but from waste products formed during their activities. It follows, therefore, that where scrupulous cleanliness is enforced there is no risk of taints from micro-organisms, but where leaf in the course of manufacture is allowed to come into contact with old leaf either on the rolling tables, fermenting floors or elsewhere, the disagreeable substances produced by the organisms in the stale leaf will become incorporated with the fresh tea and a taint produced.

Any view that the presence of old tea juice on tables etc. is necessary for the production of characteristic flavour is, in the light of these experiments, likely to prove fallacious. Such stale juices are more likely to give rise to taints than to beneficial characters and should therefore be avoided.

The importance of cleanliness is generally recognised in all Ceylon tea factories, and the results of these experiments are published not so much to call for cleanliness as to emphasise the practical importance of it.

Tea Cider:—Towards the end of June a sample of the tea "germ" for the preparation of Tea Cider was received from the Chairman of the Ceylon Tea Propaganda Committee, together with two small samples of experimental brews attempted therefrom. Attempts to brew tea cider from these cultures failed, and microbiological analysis indicated that an important constituent of the culture was missing.

Later, we obtained from the Java Tea Research Station a dried film culture; from this we were able to establish a satisfactory culture though the greater part of the film was dead. We were fortunate at this time in that Mr. G. J. Wehry, of the Tea Expert Bureau in Batavia saw our cultures and expressed the opinion that they were progressing normally. He also left with us a few bottles of the Java product for comparison. Attempts to produce further cultures from this cider failed, for unknown reasons, but we were enabled to determine that our cider compared favourably with the Java product.

Tea Cider is easily made in the home and is a very palatable drink. We have already been able to distribute numerous cultures to those desirous of trying them and we should be pleased to forward gratis a specimen culture with directions for its use to those applying for such.

The culture is a mixture of organisms of which only two are of importance viz. *Saccharomycodes Ludwigii* a yeast which ferments sugar in the presence of tannin, and *Bacillus xylinum*, a vinegar bacillus. It is the joint work of these organisms which give the Cider its characteristic flavour and bouquet. Ciders have been brewed from these two organisms alone and the resulting product is indistinguishable from those made with the normal culture. *Saccharomycodes Ludwigii* can be replaced by other yeasts capable of fermenting sugar in the presence of tannin, and it may be of interest to record that satisfactory brews have been made with yeasts obtained from the Nuwara Eliya brewery when *Bacillus xylinum* is added to them. The addition of other organisms isolated from the normal culture does not appear to have any material effect on the finished product, so their presence in the culture may be regarded as being more accidental than essential.

As the finished cider contains a small percentage of alcohol, usually less than 1 per cent. when prepared in this laboratory, it cannot be offered for sale at present. The drink is reported to have certain medicinal values and is one which appeals to many palates. As the flavour, sweetness and dryness are easily controlled during the brewing process and its manufacture is very simple, the drink is one eminently suitable for manufacture in the home.

The culture can also be used for the preparation of an excellent vinegar.

Small-Holdings:—At the request of the Board of Management an investigation into the conditions and methods of cultivation of Tea Small-Holders was made and a full report, which was later published in *The Tea Quarterly*, was presented to the Small-holdings Sub-Committee for consideration. Subsequently a special officer was appointed to assist the Small-holders by advice and demonstration.

Library:—During the year 530 books and titled papers have been added to the library. The work of indexing all titles other than those contained in journals has been continued. 74 volumes have been bound.

C. H. GADD,
Mycologist.

REPORT OF THE ENTOMOLOGIST FOR THE YEAR 1932.

Staff:—There has been no change in the staff during the year.

Advisory:—347 collections of insects were received for identification and advice, of which the majority related to Nettle Grubs; 87 visits were made to estates.

Tortrix:—There was, on the whole, a decrease in the attacks of this pest, compared with the previous year. The greatest period of activity was, as usual, during the first quarter.

Tortrix Egg Parasite:—A consignment of *Trichogramma evanescens* was received from Farnham Royal in January. This species was no easier than the local one, *T. erosicornis*, to raise in the eggs of *Sitotroga*, and reproduction was carried on in the eggs of *Corcyra cephalonica* most of the year, but was more prolific in those of *Ephestia kuehniella*.

The out-turn of grain moths in the early part of the year was again poor, the resulting production being about 3-4 per cent. of the eggs used for the purpose. As all meal for moth production is subjected to heat before use, in order to kill all competing organisms and their eggs (mainly *Tribolium* species, and mites), it seemed possible that the treatment might have some detrimental effect on its food value. A little Marmite and Cod liver oil was therefore mixed with the meal before adding the eggs, and results to date have shown a marked improvement, not only in the survival rate, but also in the fecundity of the females. Several experiments to determine the optimum quantity of these materials and the resultant yields of moths and eggs were started, and are still in progress. An account of these experiments will be published when completed.

It has been found possible to parsitise the large eggs of *Attacus vicini*, the castor silkworm, with *Trichogramma evanescens*. The proportion of eggs so far parasitised is not high, but it may be possible to raise a more fertile strain in this respect. If these eggs could be used successfully it would be easier and cheaper to produce large numbers of parasites this way than by the grain-moth method, but there are several questions arising from this aspect of the problem which have to be answered, and experiments are in hand to determine the efficacy, or otherwise, of this method.

Experiments to find out the rapidity of dispersal and propagation under field conditions are to be carried out when there are sufficient egg-masses on the bushes to allow of this being done. A stock of parasites has been built up in readiness for this purpose.

Tea Leaf Roller:—The tea leaf roller, *Gracilaria theivora*, was fairly common on St. Coombs during September, though it did not do much economic damage. In Java this species attacks the tea to a much greater extent than does the Tea Tortrix. Several parasites were bred out and sent away for identification.

Nettle Grubs:—There was a marked decrease in Nettle Grubs in 1932 in the Uva district, compared with the previous two years. The acreage attacked was considerably smaller and the severity of attack much reduced. *Natada nararia* was again the most important species economically.

Thosea cervina was reported on fifty-four occasions, one being from Bogawantalawa.

Parasa lepida was sent in for report sixteen times, and was the only Nettle Grub received from Madulsima during the year.

A few individuals of the somewhat rare Nettle Grub, *Scopelodes venosa* were taken in the latter part of the year.

Another, hitherto unknown, species of Nettle Grub was observed on tea in April, but failed to develop in captivity; drawings of caterpillars were made at Peradeniya.

A few specimens of *Miresa argentifera*, a dark-green Nettle Grub was found on tea in Passara.

Parasites:—Many parasites were recorded during the year, and the following identifications of Ceylon species were received from the British Museum, and are added to the list published in Bulletin No. 5 of the Institute, p. 18:

Host	Parasite	Family
Natada nararia	*Goryphus variibalteatus* Cam.	*Ichneumonidae*
	Hemiteles sp.	...
	Euplectrus sp.	*Eulophidae*
	Tetrastichus sp.	...
Thosea cervina	*Trichospilus pupivora* Ferr.	...
	Podomyia (Eurigaster) setosa Dol.	*Tachinidae*
Parasa lepida	*Eurytoma parasae* Gaham.	*Eurytomidae*

The following were also recorded from Java (Bulletin Entomological Research XIX, pp. 126, 127):

Apantles caniae	*Braconidae*	*Cania bilineata* Wlk.
Apantles parasae	...	*Parasa* sp.

A consignment of *Chaetexorista javana* (*Tachinidae*) was received from America, via Farnham Royal, at the end of May, and the parasites were liberated in a field where *Thosea cervina* was prevalent at the time. It is not known as yet whether the colonisation was successful.

Artificial Control of Nettle Grubs:—Several insecticides were tested with a view to suppressing activities of these pests, but none have been more satisfactory than plain soap and water.

The following contact sprays were tried:
"Volck" medium.
"Orthol" K.
Whale oil soap.
Ratsouri's Horticultural sprays 1 and 2 (a pyrethrum product).
Pyrethrum in kerosene.
Pyrethrum emulsion.
"Uno" (a pyrethrum product).
"Derrisol".
"Clensel".
Nicotine 95/98%.
Nictine sulphate.
Soap solutions.

Barium fluosilicate and arsenate of lead were also tried as stomach poisons, but the results were not encouraging.

The most satisfactory spray continues to be laundry soap ("Umbrella" brand was found as good as any) at the rate of 1 pound to 40 gallons of water, although 1 pound to 30 gallons is better for the quite young stages of Nettle Grubs. Using a charge pump and battery knapsack sprayers, the average cost worked out at about Rs. 12-50 per acre. If properly carried out, the mortality is about 80 per cent.

Legislation:—Nettle Grubs were declared a pest under the Ordinance in the early part of the year: this applies to the Uva district only, and renders it obligatory for estates to report the presence of the pest to the Department of Agriculture.

New host plants of Nettle Grub:—New host plants of Nettle Grub were recorded as under:

Species	Hosts
Natada nararia	*Eugenia javanica, Anona muricata.*
Thosea cervina	Roses.
Thosea recta.	*Jasminum* species.
Spatulifimbra castaneiceps.	Roses.
Narosa conspersa	*Citrus* species.

Predators:—The predaceous bug, *Canthecona robusta* (*Pentatomidae*) was present only in April.

Ants attacked grubs on the ground and cocoons in the laboratory, and may presumably also do so in the field.

Among birds, crows, magpie robins (*Capsychus sanlaris*), and the Southern Tits (*Parus major mahrattarum*) attacked both larvae and cocoons.

In the insectary, larvae of *Parasa lepida*, *Thosea* species and *Natada nararia* were preyed upon by the lizard, *Calotes versicolor*.

Wilt:—Wilt was present in the field during the year, and where Nettle Grubs are common, appeared to check them to a greater extent than all other natural enemies combined.

Acknowledgments:—Acknowledgments are due to the Managers of Gonakelle, Demodera Group, Telbedde, Ury and Passara Group for co-operation and assistance during investigations.

Identification of Parasites:—Apart from the parasites of Nettle Grubs already named, the following were determined by the Imperial Institute of Entomology:

Host	Parasite	Family
Homona coffearia (Tea Tortrix.)	*Phytodiaetus capuae* Morley.	*Ichneumonidae.*
	Stictopisthus sp.	
	Microdus sp.	*Braconidae*
	Apanteles sp.	
	Brachymeria euploae West w.	*Chalcididae.*
	Elasmus homonae Ferr.	*Elasmidae.*
	Tetrastichus sp.	*Eulophidae.*
Gracilaria theivora (Tea leaf roller.)	*Dioctes* sp.	*Ichneumonidae.*
	Ampiesella india Girault.	*Eulophidae.*
Psyche vitrea (Bag worm)	*Brachymeria euploae.*	*Chalcididae.*
	Anastatoidae brachartonae Graham.	*Eupelmidae.*

Other Pests:—The following pests, in addition to those mentioned, were found attacking tea, and sent in for report:

Leaf-eating caterpillars.

Bagworms.

Argina sp.

Twig caterpillar, *Boarmia bhurmitra* Wlk.

Notolophus posticus Wlk.

Terias silhetana Wallace.

Red Slug, *Heterusia cingala*, Moore.

TABLE I.

DISTRIBUTION OF NETTLE GRUBS IN 1932

(Figures relate to number of estates from which specimens were collected and sent to the laboratory for identification.)

Planting District	Natada nararia	Thosea cervina	Thosea recta	Parasa lepida	Narosa conspersa	Spatulifimbria casteneiceps	Belippa laleana	Scopelodes venosa
Badulla	24	17	15	1	14	9	—	1
Balangoda	—	1	—	—	—	—	—	—
Dimbula	—	2	—	—	—	—	—	—
Haputale	3	6	2	2	3	—	—	—
Madulsima	—	—	—	1	—	—	—	—
Nilambe	1	1	—	—	1	—	—	—
Passara	29	27	21	10	20	11	3	4
Pussellawa	—	1	—	1	1	—	—	—
Uda-Pussellawa	1	—	—	1	—	—	—	—
Total Number of collections	58	55	38	16	39	20	3	5

TABLE II.

NETTLE GRUB RETURNS 1932.

(Figures in first four horizontal columns refer to the number of estates which sent in returns, out of a total of 126.)

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.
Report no attack	53	48	55	42	43	73	60	56	64	75	69
,, mild attack	6	9	11	13	11	14	12	8	10	5	3
,, medium attack	2	1	—	1	1	3	2	3	2	1	2
,, severe attack	—	—	—	—	—	—	—	—	—	—	—
Total number of estates attacked	8	10	11	14	12	17	14	11	12	6	5
Approximate acreage affected.	555	621	746	1168	772	1136	980	1031	972	978	543

Plant-sucking bugs.

Tea Aphis, *Toxoptera aurantii* Boyer.
Helopeltis antonii Sign.
Pinnaspis theae Mask.
Ricania fenestrata F.

Mites.

Red spider, *Tetranychus bioculatus* W.M.
Yellow mite, *Tarsonemus translucens* Green.
Scarlet mite, *Tenuipalpus obovatus* Donn.
Purple mite, *Eriophyes carinatus* Green.

Borers..

Shot-hole borer *Xyleborus fornicatus* Eich.
Red Borer, *Zeuzera coffeae* Nietn.

The following pests from green manure and shade trees were received for identification and advice :—

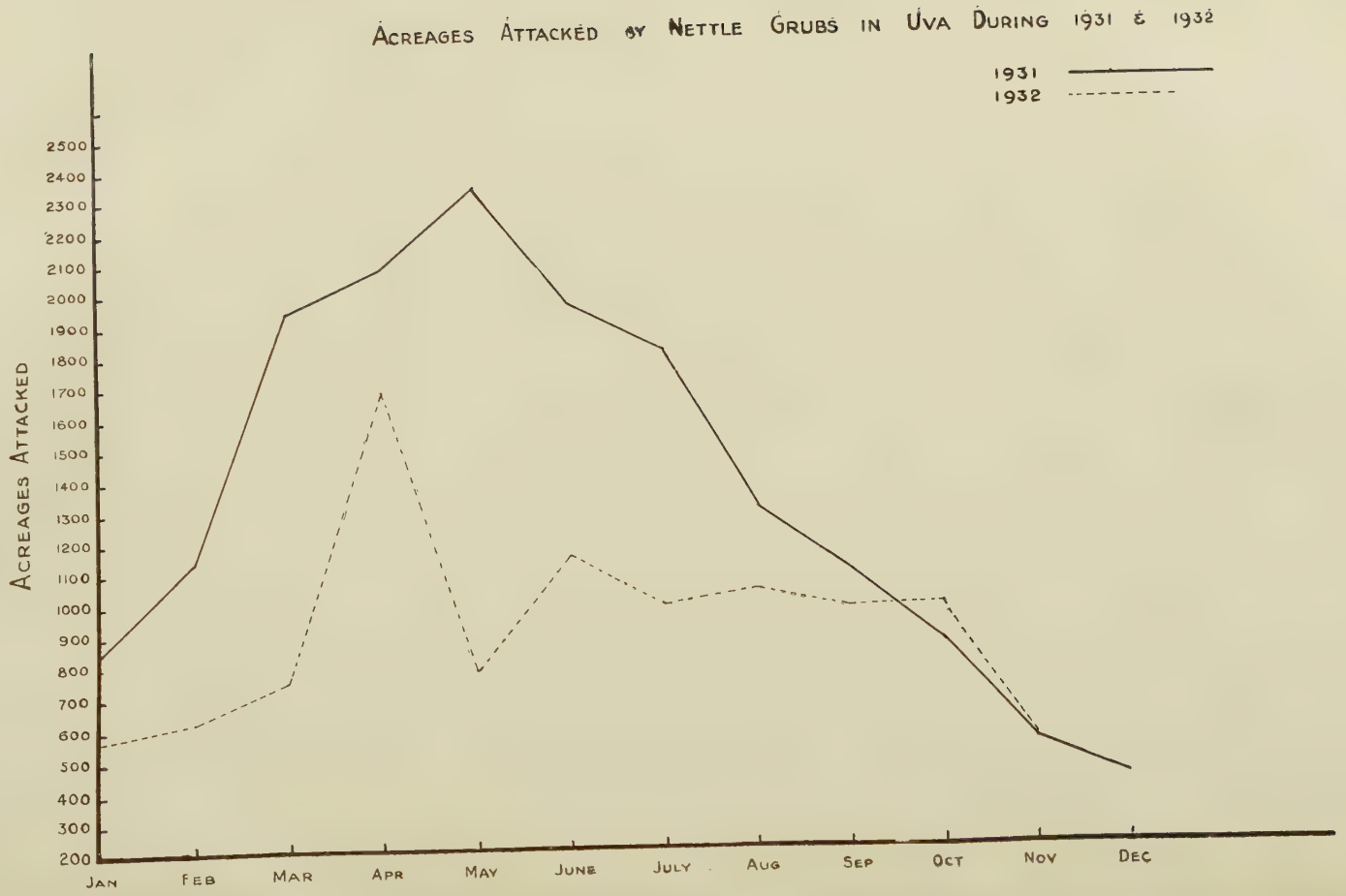
Leaf-eating caterpillars.

Acheronitia spp.	Dadap.
Dasychira sp.	...
Taragama dorsalis Wlk.	...
Terias silhetana Wallace	*Albizzia* and *Acrocarpus.*

Borers.

Arbda quadrinotata Wlk.	*Albizzia.*
Xyleborus sp.	*Grevillea.*

C. B. REDMAN KING.
Entomologist.


ACREAGES ATTACKED BY NETTLE GRUBS IN UVA DURING 1931 & 1932
1931
1932
ACREAGES ATTACKED
2500
2400
2300
2200
2100
2000
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEP
OCT
NOV
DEC

REPORT OF THE PLANT PHYSIOLOGIST FOR 1932.

Correspondence:—A further increase in correspondence occurred in 1932, 343 letters being received and 401 letters sent out. These include correspondence referred to this Department during the absence of the Agricultural Chemist.

Visits:—The number of estates visited during the year was twenty four, a total of forty nine visits being made.

Staff:—The Plant Physiologist acted for the Agricultural Chemist until October 12th, 1932, in addition to his departmental duties.

Mr. I. R. Nicol resigned his post as Field Assistant on 31st October, and Mr. F. H. Kehl was appointed to fill the vacancy. Mr. D. Nicol was placed in charge of the Galatura pruning experiment in April.

Stumping Experiment:—At the end of July, 1931, an experiment to determine the effects of five different planting treatments upon two-year-old Cranley jât seedlings was initiated. It was superimposed upon an experiment of the Agricultural Chemist's, a fact which rendered possible the examination of the effect upon the growth of the plants of burning patna grass previous to opening compared to forking it in unburnt.

The five treatments were:—

(a) Planted intact as lifted from the nursery.
(b) All leaves and green wood removed, the roots being left untouched.
(c) As (b) with all lateral roots removed.
(d) Stumped to six inches, the roots being untouched.
(e) Stumped to six inches, all lateral roots being removed.

The weather succeeding planting was very good, as is indicated by the attainment of a mean percentage of successful establishment of 93·6 per cent.

The influence of patna treatment and of the five stumping treatments upon the percentage established has been studied, the results being given in Table I.

TABLE I.

	Stumping treatment —					Means of six plots	Patna treatment—15 plots		
	a	b	c	d	e	Mean	Burnt	Unburnt	Mean
Percentage establishment	77·7	96·5	97·7	97·6	98·3	93·6	92·6	94·6	93·6
Standard error			2·34					1·50	
Percentage establishment as a percentage of the mean	83·1	103·1	104·4	104·3	105·1	100·0	99·0	101·0	100
Standard error %			2·50					1·61	

The error associated with means of six plots is 2·34, requiring differences of more than 7·02 between pairs of treatments before they can be judged to be significantly different. The differences between treatment (a) and the remaining four alone fulfil this condition. The characteristic of treatment (a), which results in a significantly smaller establishment than the remainder, is the retention of leaves on the plant. The results obtained are probably due to excessive loss of water from the root during the first period after planting before the leaves have dropped off, leaves and young stems being much more active in releasing water to the atmosphere than are those portions which are covered with a corky layer. The practice of using plants as removed from the nursery, untouched, when refilling vacancies in old tea, has been adopted on some estates, mainly in order that the young supply should be in a better position to avoid damage and to compete with the established bushes for light and air. The same result is obtained, with a higher percentage of establishment, by using plants from which all leaves and green wood have been removed, leaving the red wood of the central stem untouched.

It is interesting to note that the presence of lateral roots upon the main taproot did not result in any better establishment, as is shown in Table II.

TABLE II.

With Roots		Without Roots	
Treatment (b)	96·5	Treatment (c)	97·7
Treatment (d)	97·6	Treatment (e)	98·3
Total	194·1	Total	196·0

The effect of patna treatment on establishment was not significant in spite of the low error of the experiment. Under the very favourable climatic conditions experienced, this was to be expected since the only way in which the provision of a mulch of dry grass is likely to affect establishment is by reducing the loss of water from the soil surrounding the stumps during periods of dry weather. A more marked effect might be expected in seasons in which periods of dry weather occur soon after planting. In this connection it is suggestive to note that although the interactions of stumping treatment with patna treatment was not significant, the bulk of the "sum of squares" due to this interaction was associated with treatment (a), in which water shortage was most likely to occur.

Seventeen months after planting, an examination was made of the thickness of the stem at ground level. No effects of patna treatment or of stumping treatment were discernible.

It is proposed to continue these observations further and in addition to examine the effects of early and late pruning of young tea clearings.

The distribution of branches and flush within the bush [1] :—An examination of the spatial relations of the branches at the pruning level in an unpruned bush showed that the number of branches per square foot of surface was greatest in the centre of the bush and decreased as the edge of the bush was approached. This tendency to produce more growth in the centre of the bush than laterally, is a reflection of the natural habit of the bush, and is observable in the distribution of tipping shoots, in the branches of a plucked bush, in the distribution of flush upon its surface and finally in the domed shape acquired by bushes towards the end of their cycle.

Pruning:—The laying down of the experiment to determine the effect of time of pruning and of elevation upon the reaction to three types of pruning has been completed.

The three types of pruning used were clean pruning, rim lung pruning in which six lungs per bush were left, and cut across pruning, *all three being at the same level.* Further particulars may be obtained from previous publications [2] [3].

It is desired to record the gratitude of the T.R.I. to the Director of Agriculture and his officers for their co-operation in the provision of facilities at Peradeniya, and also to Messrs. James Finlay & Co., Ltd., the Amalgamated Tea Estates Co. Ltd., and the Superintendent, for the accommodation and help provided at Galatura.

It is not proposed to discuss the yields so far obtained, as conclusions drawn from the first few months of a pruning cycle must necessarily be incomplete and may possibly be misleading. Sufficient data have, however, been obtained upon some of the aspects of recovery from pruning to warrant their discussion.

(a) *Dieback* :—The Galatura portion of the general pruning experiment has yielded interesting results upon the influence of different types of pruning upon the dieback of high jât bushes after pruning at an elevation of 200 feet above sea level. The results have already been discussed [4], and may be briefly summarised here.

(1) Clean pruning results in significantly more deaths after pruning than does rim lung pruning or cutting across. The difference between rim lung pruning and cutting across is not significant.

(2) The amount of dieback of branches in clean pruned plots is greater than in rim lung pruned or cut across pruned plots. In cut across plots more dieback occurs than in rim lung plots.

(3) The amount of dieback varies in different blocks of the experiment and is possibly associated with soil fertility. The blocks showing the larger amounts of dieback are those whose tipping yields and flush yields to date are the lowest. The association of dieback with the production of a small amount of tipping material might be attributed to the direct effect of the dieback, but the fact that seven months after pruning (November) the yields show the same distribution, strongly suggests that fertility of the soil may be the real cause of the variation of dieback in different blocks, since jât and aspect are uniform. The relevant data are shown in Table III.

TABLE III.

Blocks.	Weight of dieback in lbs.	Dry weight of material removed in first tipping in lbs.	Dry weight of flush produced in Nov. 1932 in lbs.
G	160	13·99	19·45
H	180	14·20	18·22
I	125	18·70	21·07
J	81	20·56	22·09
K	85	20·10	19·79
L	72	23·65	21·30

There are two alternative explanations of this apparent effect of soil fertility; firstly, that fertility of the soil directly influences the amount of carbohydrate stored by the bush; secondly, that mineral reserves have an importance similar to carbohydrate reserves in relation to the causation of dieback after pruning, their deficiency having similar results. Further investigations to elucidate aspects of these problems are in hand at Galatura i.e., the variation in chemical composition of branches previous to pruning, and the effect of variation in the previous yield upon dieback after pruning. Other allied investigations in hand are the effect upon wood-growth of resting after pruning and the relation between yield and total leaf area.

(b) *Time of removal of lungs*:—An experiment upon the relation of time of removal of lungs to the growth of young shoots in rim lung pruned bushes was performed. The experiment not being conclusive, it is hoped to re-examine this question.

(c) *Resting*:—An observational experiment upon the effect of resting for eight months from collar pruning compared to fourteen months gave evidence of a distinct increase in thickness of the wood at 18 in. above ground level (the height at which it was cut across) at an elevation of 1,800 feet above sea level. No increase in damage by shot-hole borer due to the longer period of resting was noticeable.

(d) *Tipping growth*:—In practice it was found impossible to judge pre-tipping growth sufficiently accurate to ensure that plots were tipped at exactly the same stage. As a result, the amount of material removed, i.e., flush plus material broken back in the tipping operation, varies. The results obtained may be compared by ascertaining the average growth rate up to the third tipping by obtaining the value for each plot of total weight of material broken back on the three tippings divided by the number of days from pruning to third tipping.

This figure does not provide an accurate estimate of the growth rate of new shoots, but is the rate of production of new stem and leaf above the level of tipping.

The data will be more fully discussed elsewhere, but the conclusions derived may be briefly summarised.

(1) The effect of pruning treatment at St. Coombs upon the "growth rate" is strongly significant, cut across bushes growing faster than rim lung or clean pruned bushes, there being no significant difference between the two latter.

(2) The effect of time of pruning is not significant; i.e. up to the stage of third tipping, the effects of pruning at the end of August 1931, the end of December 1931, and the end of April 1932 do not differ significantly at St. Coombs.

(3) The interaction of pruning treatment with time of pruning is significant, there being a tendency for different types of pruning to react differently, relative to each other, at different times of the year.

(4) The effect of varying elevation upon reaction to pruning is summarised below.

Place	Elevation	Relative Order
St. Coombs	4,600 feet.	Rim lung $<$ Clean prune $<$ Cut across.
Peradeniya	1,500 feet.	Clean prune $<$ Rim lung $=$ Cut across.
Galatura	200 feet.	Cut across $<$ Clean prune $<$ Rim lung.

$A < B$ denotes that A is significantly less that B.

$X > Y$ denotes that X is significantly greater than Y.

$P = Q$ denotes that P does not differ significantly from Q.

(5) The effect of pruning treatment in the elevational experiment considered as a whole is not significant owing to the large pruning treatment × elevation interaction. This interaction is strongly significant, a fact that indicates the change in relative "order of merit" of the different treatments at varying elevations.

(6) The effect of elevation is just significant, the growth rate at Peradeniya being significantly greater than at Galatura.

The effect of Defoliation:—The results of two experiments upon the effect of defoliation on the yield of flush and upon the thickness of the pruning wood have already been discussed [5]. The results obtained showed that defoliation produced an immediate reduction in yield which was terminated by a period of enhanced yield. This was, however, not maintained, a second reduction in yield occurring, that was probably the result of the drain upon the carbohydrate reserves resultant upon the production of flush without an adequate leaf area to support it. As the leaf area of the bush increased, the yield again recovered. Defoliation also caused a significant decrease in the rate of thickening of the stems at the pruning level.

Resting is recommended for areas suffering from the effects of defoliation by insect or fungal pests. Where pruning is recommended as treatment for the eradication of the pest, it is desirable to perform this before the bush produces new leaves at the expense of the internal reserves required for efficient recovery from pruning.

Seed Races:—Further importations of seed have been made during the year, including small quantities of seed of four races of Formosa Oolong teas which were obtained by the aid of H.M. Consul, to whom the Institute is also indebted for information upon the methods of vegetative propagation of tea practised in that Island.

Vegetative Propagation:—Investigations on layering, green and hardwood cuttings, and split seedlings of various ages continue. The latter method is being used to provide a uniform area of tea for small scale single bush experiments.

Witches Broom:—The injection of a solution of

Potassium nitrate	...	10·00 grammes.
Sodium chloride	...	5·00 grammes.
Calcium sulphate	...	5·00 grammes.
Magnesium sulphate	...	5·00 grammes.
Calcium dihydrogen phosphate		5·00 grammes.
Potassium iodide	...	0·50 grammes.

Sodium borate.	...	0·50 grammes.
Magnesium sulphate	...	0·50 grammes.
Ferrous sulphate	...	0·50 grammes.
Potassium bromide	...	0·50 grammes.
Copper sulphate.	...	0·50 grammes.
Water	...	10 litres.

into branches of badly affected bushes did not induce recovery.

Bushes transferred from Witches Broom areas to well manured and deep cultivated soil ("spoil soil") at St. Coombs showed some mortality as a result of the move, but of those that survived, several may now be adjudged healthy, while the remainder appear to be recovering.

REFERENCES.

(1) Tubbs, F. R.—*Tea Quarterly* 1932, 5, 25-26.
(2) Tubbs, F. R.—*Tea Quarterly* 1931, 4, 103-105.
(3) Tea Research Institute of Ceylon, *Bulletin* No. 8, 31-33.
(4) Tubbs, F. R.—*Tea Quarterly* 1932, 5, 108-111.
(5) Tubbs, F. R.—*Tea Quarterly* 1932, 5, 148-153.

F. R. TUBBS,
Plant Physiologist.

REPORT OF THE AGRICULTURAL CHEMIST FOR 1932.

Staff:—The Agricultural Chemist was on leave until October 10, 1932, during which time Mr. C. A. de Silva was in sub-charge.

During his furlough in England, the Agricultural Chemist spent some months at the Rothamsted Experimental Station, Harpenden, in the Statistical Department and at the Imperial Bureau of Soil Science.

Recent developments in statistical and field experimental methods were studied, and the opportunity was taken to review the extensive literature on Soil Erosion in the files of the Bureau. The results of this work will be published later.

Acknowledgments:—It is a pleasure to thank Sir John Russell, F.R.S., Director of the Rothamsted Station, Dr. R. A. Fisher, F.R.S., Head of the Statistical Department, and Mr. G. V. Jacks, M.A., Deputy-Director of the Imperial Soil Bureau for the hospitality extended whilst this work was in progress; and Messrs. F. R. Tubbs and J. A. Rogers for their co-operation in the work of the division during the leave period.

Advisory:—The majority of advisory letters have passed through the Physiological Department. Subsequent to the arrival from leave of the Officer-in-charge of the Division, 54 letters were received and 57 despatched. The main subjects of inquiry have been manuring under slump conditions, and the intensive use of green manures.

Publications:—Studies in the Yield of Tea II. The seasonal and sampling variation in yield and mineral composition of the tea leaf.—*Journal of Agricultural Science 1932, Vol. 22.*

Soil Reaction:—Attention has been called in previous reports to the effect of alkalinity on the development of young tea. Where the trouble extends over large areas, the cost of remedial measures is prohibitive. Cases sometimes occur in nurseries, where, because of convenience of position, it is not desired to abandon the site. In such instances treatment with sulphur is advocated, and the results of one such trial are now at hand.

The estate in question had an area of young tea which had been replanted because of the failure of a previous planting. At the time of the visit in January, 1930, this planting also was in a moribund condition. In parts, the soil had a highly alkaline reaction giving a value of 8·27 on the pH scale. Plots were set out, half of which were dressed with flowers of sulphur at the rate of 10 cwt. per acre, the remainder being kept as controls.

Subsequent determinations of reaction have shown the following results:—

Mean pH values.

	With Sulphur	Without Sulphur
August 1930 ...	5·00 ...	7·06
July 1932 ...	4·80 ...	—

Later the plots without sulphur were given a similar sulphur dressing; consequently no figure was available as control in 1932.

A second series started in September 1930 shows the following changes:

	pH
Before sulphur application (September 1930)	7·31
After sulphur application (July 1932)	6·61

The report of the Superintendent on the treated plots of the first series is as follows:—

"Tea has been established on these blocks with fair success; previously no success was attained. The plants have weathered a drought, and though not very handsome, are green and growing."

Drainage and Clearing Experiment:—Measurements of soil erosion and run-off on the drainage experiment, a short description of which was given in the previous report, have been prevented by the extraordinary even distribution of rainfall in 1932. The self-recording rain-gauge shows that falls of one inch per hour were experienced during the hours of daylight on only eight occasions and that in no case did these rain storms give more than a total fall of two inches. Thus weather conditions have been unfavourable for the collection of the required data.

Whilst clearing the pits formed by bunding an ordinary open drain with concrete blocks, the opportunity was taken of measuring the amount of soil held up between October 1931 and mid-May 1932. The details are appended.

Slope of land	30%
Total rain	47·5 inches.
Soil per acre collected.	32,340 pounds.
Pounds soil per acre inch of rain	681

In a period of well distributed rainfall the losses of fertile top soil are thus seen to be considerable. Even so simple and incomplete records as these show how necessary it is to preserve this soil by a system of drains which makes use of bunds, silt-pits, or reverse slopes for the interception of eroded soil.

Potash and Nitrogen Experiment:—The second year of the pruning cycle in this experiment was completed in November. The full results are being dealt with in a paper at the 1933 Conference; the following is a summary of the results and conclusions drawn from the present year's work.

The design of the experiment is described in the appendix to the 1931 report; its main outlines are repeated here for the sake of convenience. The experiment is intended to provide information on the effect of increasing quantities of nitrogen and potash in their several combinations, and on their interactions. Both fertilisers are given in dressings of 20 and 40 pounds per acre with a constant dressing of 30 pounds of phosphoric acid in the form of superphosphate. The nitrogen treatments are equally divided between three types of nitrogen Blood meal, Cyanamide and Sulphate of Ammonia. Manures were applied at time of pruning and twelve months later.

It is satisfactory to report that the accuracy of the experiment has been maintained. Any possible increase in variability of the plots, due to irregularities in bush size and shape, that have developed during the course of the pruning cycle, have been more than offset by the larger number of pluckings upon which this year's results are based, (40 rounds compared with 25 in the year following pruning).

The following are the percentage errors computed for the two years:—

Percentage Errors of Means.

	1931	1932
For nitrogen and potash quantity comparisons	1·9	1·8
For comparisons between types of Nitrogen.	2·3	2·2

Yield responses in the first year were so small that they were of no practical importance, and did not exceed the known errors sufficiently to be ascribable to the various treatments. This year the plots receiving nitrogen have given significant increases in yield. The different kinds of nitrogen have been equally effective, and no significant differences can be detected between them. Potash manuring has produced no response in yield.

As regards potash and the differentiation between the several forms of nitrogenous manuring, these results repeat the findings of the first year. The response to increments in quantity of nitrogen applied is in marked contrast to previous results. It is of interest that up to the level of 40 pounds nitrogen per acre, yield increments show no sign of falling-off.

A summary of the yields and errors are given in the following table:—

Potash and Nitrogen Experiment (2nd Year).

	Nitrogen Quantities			Potash Quantities			Nitrogen Type		
	Nil	20 lb. per acre.	40 lb. per acre.	Nil	20 lb. per acre.	40 lb. per acre	Blood-meal	Cyan-amide	Sulphate of Ammonia
Yield per acre lb. dry weight	878	942	1025	952	932	961	990	967	994
Standard Error lb.		16·9			16·9			20·7	
Yield per cent. of mean.	92·6	99·4	108·0	100·4	98·3	101·3	100·7	98·3	101·0
Standard error per cent.		1·79			1·79			2·18	

The Influence of Organic Matter on Fertilizer Values:—The foregoing experiment deals in part with the relative efficiency of artificial nitrogenous manures of an organic and inorganic nature. At the present time this question assumes special importance in the consideration of manurial policy. It is intended to extend this work by comparing the effect of organic and inorganic nitrogen on land containing, in one instance, only moderate supplies of soil organic matter, and in another, applications of decomposed vegetation as heavy as opportunity provides.

For the sake of convenience, the organic matter is being applied in the form of a mixed compost of patna grass, sunflower and *Tephrosia Vogelii,* prepared by the "adco" process. The tea on the area treated is not yet in bearing, and by the time maturity is reached, it is hoped that the soil will be stocked with compost sufficiently to give useful comparisons.

An area of 3 acres has been divided into six blocks, three receiving ordinary estate treatment, and three receiving the compost. On these blocks various artificial nitrogenous manures of both organic and inorganic types will subsequently be superimposed. During the past year the following quantities of organic matter have been forked in.

Time of application	May 16-23	October 17-20	
Rate per acre, lbs.	11,600	15,400	27,000
Moisture content per cent.	75	85	
Dry matter	2,900	2,310	5,210
Nitrogen in dry matter, per cent.	1·68	1·71	

Green Manure and Cover Crops:—Following the difficulty of raising seed for a number of crops, details of which were given in the previous report, small beds for raising seed and for propagation were prepared in the laboratory compound, where watering and seed collection could be advantageously carried out.

The following species were propagated:—

Vigna marina.
Dunbaria Heynei.
Calapogonium mucunoides.
Atylosia scarabaeoides.
Pueraria phaseoloides.
Parochetus communis.
Crotalaria madurensis.
Pycnospora lutescens.
Pycnospora hedysaroides.

The two species of the genus *Pycnospora* made no headway at all.

In addition, two localities, one under mature tea, and one on a portion of the 1931 clearing, were divided into a series of quarter-acre demonstration plots and planted with the following types:—

Indigofera endecaphylla.
Dolichos Hosei.
Centrosema pubescens.
Calapogonium mucunoides.
Atylosia scarabaeoides.
Polygonum nepalense.
Parochetus communis.
Centella asiatica (violet weed)
Cassia mimosoides.

With the exception of the *Atylosia* and the *Cassia* species, for which the material was not in the best condition for planting at the time, the plots in the mature tea are all showing various degrees of active growth six months after planting. On the clearing, *Calapogonium* only has maintained a hold.

By far the most promising of these species is *Parochetus communis*, an indigenous plant, for whose introduction as a cover crop we are indebted to Mr. B. E. Graham Oliveira. Parochetus has a trefoil leaf resembling Oxalis but is leguminous. It has a creeping habit, a shallow rooting system without bulbs, and a light blue pea-like flower. It does not climb, and forms, under favourable circumstances, dense cushions. It dies back in the dry weather.

Seed is by no means easy to collect in quantity though it flowers freely; it can be advantageously propagated from divided plants, and a small quantity of cattle bulk manure dibbled in at planting materially helps its establishment.

It remains to be seen whether the difficulty of establishing this valuable species in exposed situations of low fertility, can be overcome. The provision of a mixed cover to provide temporary shelter may be useful. Arrangements are in hand to propagate this species on a scale sufficiently large to meet our own requirements, and to distribute to superintendents who wish to give it a trial.

T. EDEN,
Agricultural Chemist.

REPORT OF THE BIOCHEMIST FOR 1932.

Correspondence:—1075 letters were received, and 835 despatched.

Samples:—1826 samples of tea were received during the year, mainly for moisture determination. This work was relieved to a certain extent by the introduction of the set for determining moisture in tea. Occasionally samples are sent in for tasting, but it cannot be too strongly emphasised that the Department cannot undertake to give general reports on teas.

Staff:—Mr. B. N. Sastri resigned in April, and Mr. E. L. Keegel and Mr. P. R. Perera were appointed in his stead in March and April respectively.

Estate Visits:—65 factories have been visited during the year in an advisory capacity.

Lectures:—Papers dealing with various aspects of tea manufacture were read at the following P. A. Meetings:—Dolosbage, Ratnapura, Matale, Kandy, Nuwara Eliya and Pussellawa.

Publications:—*Bulletin No. 7*, Handbook concerning tea manufacture at St. Coombs; *Bulletin No. 9*, Tea manufacture in Ceylon.

Manurial Experiments:—The leaf harvested from the manurial plots has been manufactured after each pluck in the same way as in 1931, so as to compare the teas made from leaf grown on plots which received no nitrogenous manure (designated no nitrogen teas) against teas made from plots which had received a double dose of nitrogen, (and designated double nitrogen teas). The manurial treatments of the plots were as follows at pruning and 1 year later:—

No nitrogen plots received 30 pounds potash and 30 pounds of phosphoric acid per acre.

Double nitrogen plots received 30 pounds potash, 30 pounds phosphate and 40 pounds nitrogen.

It was found that the ordinary commercial method of reporting on the tea samples did not throw much light on any difference in the teas, and a new method of reporting was tried out during the year. This method consists in comparing certain characteristics of the liquors of the teas to be tested with those of a standard tea sample, the characteristics chosen for comparison being colour, strength, pungency, quality and flavour. A sample of estate B.O.P. was sent down with each set of samples and for ease of recording given 10 marks for each characteristic. The experimental samples were compared with this standard sample and given marks for each characteristic according to the way they compared with those of the standard.

Experience of this method of marking indicates that the best results are obtained by a combination of this and the ordinary commercial method of reporting on tea samples.

The samples were sent to a number of tasters and the average marks given were taken as the correct evaluation of the teas.

The average valuation for all samples during 1931 was 100 cents per pound for both the no nitrogen and double nitrogen teas.

The total marks gained by the two sets in 1932 are given in Table I.

TABLE I

Marks gained by the manurial sample teas.

		No Nitrogen	Double Nitrogen
Colour	...	332·0	309·5
Strength	...	367·0	366·5
Pungency	...	402·0	385·6
Quality	...	438·0	427·7
Flavour	...	346·6	362·2
		1885·6	1851·5

The maximum marks obtained by the standard for each characteristic should be 340 but no flavour was reported present in 2 sets so that the marks gained for flavour by the standard was 320.

The teas have therefore given better liquors than the standard in every respect except in colour where the double nitrogen teas have obtained less marks than the no nitrogen teas, and the standard samples. It seems therefore that the application of manure has resulted in slightly less coloury teas. There does not appear to be any difference in strength but the no nitrogen teas have beaten the others in pungency and quality although peculiarly enough the double nitrogen teas take precedence when flavour is considered.

The difference in marks for pungency, quality and flavour allotted to the no nitrogen teas as compared with the double nitrogen teas for each month is shown in Table II.

TABLE II

Monthly Differences in No Nitrogen and Double Nitrogen Teas.

Date	No. of Samples	Pungency	Quality	Flavour	Colour & Strength
January	1	+3·0	0·0	−2·0	+7
February	4	+9·0	+3·0	−5·0	+8
March	3	+3·0	+3·0	−2·0	0·0
April	3	−14·0	−9·0	16·0	+10
May	4	+4·0	+6·0	+1·0	+5
June	3	+7·0	+6·0	+8·0	−12
July	4	+1·6	+3·0	+2·0	+1·6
August	3	+3·2	−0·3	+0·9	+2·8
September	3	−1·4	+1·6	0·0	+2·1
October	3	−2·5	−2·0	−3·5	+0·5
November	3	+3·5	0·0	+1·0	−3·5

(+Signifies excess and −less marks.)

The double nitrogen teas were preferable to the no nitrogen teas in pungency, quality and flavour in April for some reason and this preference was shown for all the samples sent to the tasters that month as will be seen from the following list of marks :—

Date	Pungency	Quality	Flavour	Colour & Strength
4.4.32	−4	−4	−6	0
13.4.32	−7	−5	−8	+8
22.4.32	−3	0	−2	+2

The teas prepared during the month of April were made from quicker growing leaf, but it is remarkable and quite unexpected to find that the rapid growth has detracted more from the pungency, quality and flavour of the teas from the unmanured than from the manured plots. It will be interesting to see whether this behaviour will be repeated in 1933 or not.

Colour and strength appear to be more pronounced in the unmanured teas, but the differences do not appear so marked as to offset the greater crop obtained from the manured plots.

Samples of the teas made were also analysed, but no marked difference could be found as a result of applying the nitrogenous manures except in connection with the amount of nitrogenous substances extracted by boiling water from the made tea. The extracts of teas made from leaf treated with the double dose of nitrogen had a higher nitrogen content than the others from October 1931 onwards.

Samples of these teas have also been stored and it is interesting to observe the effect of age from pruning on the colour of the infused leaf. The first few plucks gave dull greenish infusion, but later plucks show a gradual development of the coppery colour aimed at in tea infusions after October, i.e., 5-6 months after the first tipping. Good coloured infusions were not obtained until the tea was in the second year, and the difference between the infusion of tea made in December 1931, and December 1932 is most marked, the latter giving a "new penny" coloured infusion while the former gave a bright but greenish infusion.

The nature of the cream formed in cooling also varies according to the age of the tea from pruning, since the earlier teas creamed to a dark coloured liquor, while the older teas give a much lighter coloured creamy liquor.

Pruning Experiments:—The leaf harvested by the Plant Physiologist from the plots arranged by him for testing out different methods of pruning has also been manufactured after each pluck and treated in the same way as the manurial leaf. Two methods of pruning have been considered from the point of view of manufacture i.e., cut across prune and clean prune.

The general details of these plots are as follows:—

Cut Across:—Cut across at same level as clean prune in September 1931.

Clean Prune:—Cut September 1931.

The marks gained by the two sets during 1932 are given in Table III.

TABLE III

Marks given—Pruning Sample Teas.

		Cut Across	Clean Prune
Colour	...	202·6	208·1
Strength	...	219·8	220·7
Pungency	...	204·1	195·9
Quality	...	229·5	222·1
Flavour	...	172·7	167·3
		1028·7	1014·1

The teas made from the plots which were cut across have therefore gained a slight preference over the teas made from the plots which were clean pruned, but the difference is very small.

It is, however, interesting to note that whereas the experimental teas in their second year from pruning (manurial samples) have beaten the standard by a fair margin, the teas in the first year have not come up to

the standard in total marks. Since all the teas have been manufactured similarly this is an indication of the effect of age of the leaf from pruning on the tea made at this elevation. This can be seen from the following figures :—

Tea 1st year from pruning	...	1028·7 1014·1
Standard ...	...	1100
Tea 2nd year from pruning	...	1885·6 1851·5
Standard ...	...	1680·0

The difference in marks allotted to the clean pruned teas as compared with the cut across teas for each month is given in Table IV where + signifies excess and – less marks.

TABLE IV

Monthly Difference in Clean and Cut Across Teas.

Date	Colour	Strength	Pungency	Quality	Flavour
May (2)	+1·0	0·0	0·0	–1·0	0·0
June (4)	–2·6	–2·7	–3·2	–4·8	–1·6
July (3)	+0·1	–1·9	–4·4	–2·7	–2·1
August (4)	+2·9	+0·8	0·0	–0·4	–1·8
September (2)	+1·6	+1·0	–2·0	–2·3	–0·8
October (3)	+1·0	+1·0	–1·0	–1·0	–0·5
November (4)	+1·5	+2·7	+2·4	+4·8	+1·5

On the whole the clean pruned teas have been superior in colour and strength whereas the cut across teas have beaten them in pungency quality and flavour up to November when the clean pruned teas have taken the lead in all respects.

Withering Experiments:—Many experiments were carried out during the year to test the effect of withering under different conditions on the made tea. The results are of great interest, and show that results obtained during one period are not necessarily of general application. The maximum information from the withering investigation can only be obtained by testing one variable at a time, such as period of withering, for an extended period in a systematic way.

During the year under review this method was not adopted since it was considered essential to obtain some general information of the effects produced by withering in different ways before proceeding to a more detailed investigation. The results obtained have justified this from the advisory side of the Institute's work, since they have been a great help in this connection.

(a) *Period of Withering.*—Leaf was spread under certain atmospheric conditions in such a way that the necessary degree of wither was obtained in varying time periods. The effect of period of wither can be clearly seen from Table V. where a bulked weight of leaf was divided into three portions, and withered at different speeds.

The results obtained are quite uniform and show

(1) More colour is obtained in the liquors of the teas made from slow withered leaf.

(2) Strength is usually improved by lengthening the wither, but this is not always so.

(3) Pungency, quality and flavour are lost when the wither is slow.

(4) Colour and strength can be increased at the expense of pungency, quality and flavour.

TABLE V

Effect of withering on the tea made.

Month	Period of Wither Hours.	Degree of Wither	Colour	Strength	Pungency	Quality	Flavour
Feb.	4	50·6	9·7	11·0	11·7	10·5	11·5
	15	52·0	8·0	12·3	14·5	16·0	18·0
	45	50·0	20·8	12·1	8·0	4·3	3·8
May	14	46·6	7·2	7·5	11·3	10·8	10·3
	20	47·5	9·2	9·2	9·3	9·3	8·5
	36	46·6	11·9	9·7	5·0	5·5	3·0
Sept.	37	40·0	14·7	13·3	6·3	9·3	3·3
	13½	44·4	10·0	9·7	10·3	14·7	4·0
	36½	42·2	16·0	13·7	5·7	8·7.	3·3
	14½	44·0	10·3	10·3	8·0	11·3	4·0

It appears that leaf withered in such a short period as 4½ hours compared favourably with the teas made from leaf withered in 15 hours. It did not possess the same flavour, pungency and quality as the teas made from leaf withered in 15 hours, but there was not much difference in colour and strength. Pungency, quality and flavour are thus developed to a certain extent during withering, but there is little development of colour during this period. The development of colour seems to become active at a later stage which coincides with a loss of pungency, quality and flavour.

The effect of slow withering on the characteristics of the made tea were so strong that all tasters in London and Colombo were of the same opinion concerning the nature of the teas. In one instance a set of samples were incorrectly labelled, and the tasters were able to detect this from the liquors of the teas.

Very marked differences can be produced in the made teas by varying the treatment of the leaf during withering, and this gives the tea-maker a simple method of controlling his finished product, in so far as colour, pungency and flavour are concerned. The following are a few remarks on the teas made from leaf withered in 14-20 hours as opposed to the teas made from another sample of the same bulk leaf withered in 36-40 hours :—

"The conrast between A (14 hours) and B (36 hours) is so marked that it is difficult to value them. In our opinion we feel certain that when quality is good A would score heavily, and that at the height of the rush season B would score with its colour and strength."

"The 40 hours wither undoubtedly has a bad effect on quality and flavour, and detracts very appreciably from the pungency. The extra strength of the tea made from leaf withered in 20 hours carries the quality and flavour right through the milk. The long withered samples sit down almost entirely with the milk."

Since quality and flavour demand high prices at certain times of the year every effort should be made to maintain these characteristics when they are naturally present in the leaf. Prolonged withering should not therefore be indulged in at such times, and there does not appear to be any advantage in holding back a wither during the flavoury season unless this is demanded by the factory organisation.

When quality, pungency and flavour, are not marked in the leaf harvested and the market requires a strong coloury tea it may be beneficial to aim at producing a tea with these characteristics. The wither should not be rushed at such periods.

During these experiments it was noticed that leaf withered in such a short period as 4-5 hours was not uniformly withered, and that the fine leaf put out to ferment after roll breaking did not colour up properly during

fermentation, and the proper aroma of fermented leaf was not developed at any time during fermentation. Slow withered leaf on the other hand tended to become discoloured on the tats and to lose the fruity smell. The fermenting leaf after a slow wither colours up quickly and possesses a peculiar odour as compared with leaf withered in about 20 hours.

The period of withering is also reflected in the colour of the infused leaf which tends to be more coloury after a slow wither, and if the wither is too long the infused leaf becomes too brown and dull.

(b) *Degree of wither.*—The actual moisture content of the withered leaf does not appear to have such a marked effect on the pungency of made tea as the period of wither, but this point requires closer investigation. The effect of degree of wither can be seen from Table VI.

TABLE VI

Effect of degree of wither on made tea.

%Wither	Out-turn made tea to withered leaf	Colour	Strength	Pungency	Quality	Flavour
52·5	41·6	12·2	15·2	11·6	15·2	16·0
72·5	35·0	11·2	13·5	11·6	13·5	14·2
79·0	30·7	10·2	7·2	11·6	12·5	9·5

It will be seen from the marks gained by the teas in Table VI that there is some indication that:—

(1) Degree of wither has little effect on the pungency of the made teas.

(2) Harder wither gives more colour, strength, quality and flavour.

Another effect of a light wither is that it is more difficult to obtain a good separation of dhools as a result of rolling and roll breaking. Thus the leaf withered to 52·5 per cent. in Table VI gave 37·5 per cent. fines after three roll breakings, whereas the leaf only withered to 79 per cent. gave 12·3 per cent fines after three rolls.

(c) *Effect of Artificial Withering.*—In a similar way leaf withered artificially by the help of fans and warm air was compared with leaf which had been spread in a similar way and withered naturally under two conditions. One set was given sufficient time to become properly withered under natural conditions, while the other set was taken not properly withered when the leaf treated with warm air was considered ready. The results obtained were not very conclusive as far as the comparison between artificially withered leaf and the short period naturally withered leaf was concerned but slow

withering produced the same results as previously described. If the naturally withered leaf is only lightly withered, then the use of warm air to produce a good wither is beneficial as will be seen from Table VII.

TABLE VII

Effect of artificial withering of tea leaf.

Wither	% Wither	Colour	Strength	Pungency	Quality	Flavour
Artificially	45	7·0	12·0	14·0	14·5	7·5
Naturally	66	10·5	10·0	9·5	10·0	5·5

Artificial withering can thus be resorted to with benefit when properly controlled, and experience gained in visiting many factories in Ceylon forces me to the conclusion that the bad effects attributed to artificial withering are due to bad conditions and ignorance of how the warm air should be used. The Superintendent who boasts how little he uses his fans is often the worst offender in this respect, for when he does use his fans it is at a high temperature. In this way the fan hours are cut down but very bad effects are produced.

Tipping Leaf:—Manufacture of tipping leaf under the same condition as ordinary leaf indicates quite clearly that such leaf is poorer than ordinary leaf and that it takes a considerable time for the bush to produce good leaf after a prune. The effect of age from pruning has already been dealt with under manurial and pruning experiments, but further experiments were undertaken to try and improve the teas made from such young leaf. Little success can be claimed for these investigations so far. It is very evident however that the amount of young leaf taken for manufacture is very important, and many estates make it a practice of calculating the average age of each invoice of tea sold. The average is determined by multiplying the yield from each field by the age in weeks of each field from pruning and divide the sum of the product by the total yield

$$\text{i.e. Average age} = \frac{\text{Yield} \times \text{age from pruning of each field.}}{\text{Yield}}$$

The average age of the invoices depends of course on the yield and pruning cycle, but it varies very much from estate to estate. The longer the pruning cycle the older the invoices unless the cycle is so long that yield of the older field drops too low. This figure can thus be used as an index of quality and utility of the length of the pruning cycle. There is not enough data available to show the exact importance of this figure for the average age of the invoice.

Estates with an outstanding record of success appear to lay great stress on maintaining the average age as high as possible and attain this by manufacturing their tipping leaf and first few plucks separately. This is a good practice when possible but the pruning cycle is so short on many estates that it is not economically possible to do this to any appreciable extent.

It is often stated that tipping leaf is more sappy than mature leaf, but actual determinations show that there is little difference between the dry matter content of tipping and mature leaf. The amount of solids dissolved in the sap of tipping leaf is less, and this gives the impression during rolling that the leaf contains more water. The out-turn of made tea on withered leaf of such leaf was yet found to be quite high.

On comparing the dry teas made month by month from the same plots it is found that there is a gradual change in appearance of the dry tea as the leaf gets older from pruning. Tipping leaf gives very black, but stalky looking teas. The B.O.P. seems to be full of O.P. leaf which has a dead appearance, but older leaf gives a less black tea with a more leafy appearance. A tinge of brown appears in the teas made from the older leaf as well. It is very difficult to assess the true significance of these observations.

Manufacture of Leaf from Low Elevations:—Low-Country tea manufactured at St. Coombs did not possess any of the quality or flavour obtained with St. Coombs leaf. The colour and strength obtained on manufacturing such leaf in the Low-Country was not obtained at the higher elevation, and since there was no great improvement in quality and flavour the net result was a less suitable tea for the market buying these teas.

Firing Investigations:—So much attention has been given to the temperature of firing that another very important factor has been overlooked. This factor is the volume of air or quantity of heat required at different temperatures to evaporate a pound of moisture from fermented leaf. There does not appear to be any comparison between the volume of air delievered by the fans of different machines and their rated capacities and my experience has been that those machines with a low fan output per rated pound of tea dried give the most trouble. This volume of air could be calculated for each temperature provided the inlet temperature, exhaust temperature and specific heat of the tea were known, but it was considered that the experimental determination of this figure would throw some light on the effect of different conditions of drying on the teas made. Stress of other work and absence from the station on advisory work prevented this work being carried out as far as one would like, but several tests were carried out comparing different volumes of air at a temperature between 220 and 230°F against tea fired under ordinary estate conditions at 190°F. These experiments did not bring out any remarkable feature

concerning the effect of temperature or time of drying on the made tea from the taster's point of view in spite of the fact that some of the teas had been dried under what is generally considered to be bad conditions. It is very evident that single experiments on any point are of little value, and that it takes some time for the tasters to detect differences produced in a tea. In this connection I should like to warn tea planters against accepting as proved any opinions formed from a few hasty experiments either by themselves or more especially those so-called experts who occasionally visit the Island. Without entering into details at this juncture it may be said that approximately 2,000 cubic feet of air are required for every pound of moisture evaporated at an inlet temperature of 200-230°F if the tea is to be dried down to 3-4 per cent. moisture. It thus follows that a greater quantity of air will be required at lower temperatures. This result is given in terms of moisture since pounds of tea means nothing unless the moisture content of the withered leaf is known. Firing machines should therefore be rated according to their moisture evaporative capacity at certain temperatures, and the moisture content of the discharged tea under these conditions should be stated. It is very easy to work to a high out-turn per machine if the tea is discharged with 7-8 per cent. moisture, but if the tea discharged is to contain 3-4 per cent. moisture the output of a machine is very much reduced. If the above volume of air per pound is allowed, the exhaust temperature is about 120°F and the reports obtained show that there is a stewing effect when the temperature drops considerably below this. Exhaust temperatures below 100°F. are also generally accompanied by insufficiently fired tea. Higher exhaust temperatures do not seem to have such bad effects as low exhaust temperatures during the non-flavoury season, provided the exhaust temperature is not so high as to produce case-hardening, and this effect according to my controlled experiments is not produced below 145°F.

Factory Investigations:—Moisture determinations of all teas despatched were carried out, and as a result of the temperature records kept for the grading room and an investigation of effects produced under different conditions of temperature caused by the dryers and air movement caused by the fans, certain suggestions were made as likely to minimise the absorption of moisture by the teas during grading and storage. The main suggestion that picking over, and grading should not commence until the firing machine had been started and a supply of warm air available was adopted. Records of the moisture content of the teas for 1932 and previous years show a definite improvement in the moisture content of the teas available for packing, and final firing was not required on more than 2 or 3 occasions and that only for a few grades.

Conditions of final firing were investigated and have been reported in Bulletin No. 9.

Towards the end of the year the Board altered its policy in relation to the factory work and decided that a more definite research policy should be taken up on the commercial side of the manufacture, and arrangements have now been made for putting this policy into operation. Active co-operation with the Superintendent in carrying out this policy has been given by the Biochemical Department whose main interest in these investigations is to ensure that all experiments are given a fair trial, and above all that proper records are kept, otherwise the true value of the work will be lost. Too often one meets with enthusiasts who have carried out scores of experiments, but who have no record of any, apart from a few memoranda which means nothing to them in a few months' time.

New Machines:—During the year several new machines have been introduced. The performance of some of these machines was investigated as opportunity allowed, but the results have been very disappointing. It is not likely that any of those seen will displace the ordinary rollers but they may find a place as auxiliaries to the ordinary machines. It is advisable to treat any of these machines as experimental and not to undertake large-scale manufacture with them until thoroughly well satisfied that the proper conditions have been worked out, and that the product will be taken up by the tea market.

The Farbridge Multiflu Dryer is another recent innovation and this machine seems to be giving satisfaction where installed.

Rubbishy Teas:—Analysis of samples sent from H. M. Customs was also undertaken.

Fireproof Hessian:—Experimental manufacture of leaf withered on treated and non-treated hessian was carried out at the request of a commercial firm.

Chemical Investigations:—In addition to the work carried out in the factory a certain amount of chemical investigation has been carried out on

(1) Analysis of made teas from various countries.

(2) Sugar and starch content of tea leaf etc. and the changes produced in manufacture.

(3) Daily variation of the tannin and dry matter content of the 3 weighings of leaf received in the factory.

(4) The development of a method of preparing an extract according to the taster's method for analysis, and the application of this method to the study of tea.

(5) Chemical investigation of "Tea Cider".

Acknowledgments:—I wish to record my grateful appreciation to the following firms for such splendid help in reporting on the numerous tea samples sent to them, and for their readiness at all times to help:—

Messrs.	Forbes & Walker.	Messrs.	Heath & Co.,
,,	E. John & Co.,	,,	Sommerville & Co., Ltd.
,,	Whittall & Co.,	,,	James Finlay & Co., Ltd.
,,	George Steuart & Co.,	,,	Gordon Frazer & Co., Ltd.
,,	Lee, Hedges & Co., Ltd.	,,	C. Hope & Sons.
,,	Mackwoods, Ltd.,	,,	Wilson Smithett.

Messrs. Sanderson & Co.

D. I. EVANS,

Biochemist.

REPORT OF THE SMALL-HOLDINGS OFFICER FOR 1932.

Appointment:—I took up duties as Small-Holdings Officer in October 1932. A fortnight was spent at St. Coombs studying methods of draining, pruning and green manuring, and in discussing with the Scientific Staff the best methods to adopt in working small-holdings.

Meetings and Lectures:—Meetings of small-holders were arranged in the undermentioned villages in Uda-Palata, Udu-Nuwara and Kotmale at which simple addresses on the cultivation of tea were given.

Uda-Palata	Udu-Nuwara	Kotmale
Bowella	Wattapolla	Maswella
Naranvita	Aludeniya	Medapone Korale settlements.
Donukeulle	Karamada	
Angammana	Dehipagode	Nawalapitiya
Hindagalle	Hendeniya	Mr. C. E. Kelaart's Land
Doluwe		
Attabage-Udagama		
Legundeniya		
Kahawatte		
Harakolla and Wallahagode		
Kalugommuwe		
Ampitiya		

In these addresses particular attention was given to the usefulness of cover crops and green manures, the advantages of lock and step drains and the objects of rim lung pruning. Village Minor Headman rendered great assistance in organising these meetings and by their attendance at them.

Demonstrations:—The preliminary work at the meetings has been followed by visits to the holdings and personal talks with the cultivators. Every opportunity has been taken of demonstrating the various methods advocated on the small-holders own land. Seventy two demonstrations have been made and considerable interest in them has been exhibited by the villagers. A large number of small-holders have undertaken to work their lands under my direction; by frequent visits and personal help it is hoped to maintain their owners' interest in their improvement, so that such plots will be permanent demonstrations in the villages of the advantages to be gained from systematic cultivation.

Visits have also been made to the peasant proprietor settlement of Kotmale and Uda-Palata with the object of advising the small-holders on the best methods of opening their lands in tea. The lock and step system of draining has been demonstrated on the settlements at Telihunna and Pallepitiya.

Green Manures:—The advocation of the extended use of green manures has to be accompanied by the provision of supplies of seed and cuttings. Mr. Gimson of Kaloogalle Estate kindly supplied the small-holders of Dunukeulle and Attabage-Udagama with seed, and Mr. Paul of Mount Temple Estate generously provided Gliricidia cuttings for the small-holders of Bowella. Numerous applications have been received for green manure seed and arrangements are being made to obtain supplies for the next planting season.

General:—Considerable improvement in the condition of small-holdings in general can be achieved by attention to drainage, green manuring and systematic cultivation. The drainage of many holdings has been badly neglected and there is little systematic cultivation. Where green manures have been grown they are usually few in number and appear to be planted in a haphazard manner. Many holdings are overdue for pruning but the cultivators are now advised to delay pruning till after April.

Every assistance has been received from the Chief and Minor Headmen of Uda-Nuwara, Uda-Palata and Kotmale and my thanks are tendered to them for their willing co-operation.

Fair progress is being made with the work on many small-holdings and it is hoped that with the rains, when planting will be possible, increased progress may be reported.

R. L. ILLANKOON,
Small-Holdings Officer.

Meteorological Observations 1932.

	Temperatures				Mean Relative Humidity	Rainfall Inches	No. of Rainy days	Hours of Sunshine
	Mean. Max.	Mean. Min.	Adopted Mean.	Mean on Grass				
								hrs. mts.
January	73·2	56·0	64·6	48·6	68	0·13	3	258·30
February	74·9	50·6	62·8	42·7	58	5·12	9	257·51
March	75·7	55·2	65·5	49·3	66	3·06	11	215·52
April	75·2	57·0	66·1	53·9	79	6·94	13	222·38
May	71·7	60·2	66·0	58·9	85	12·58	27	103·53
June	69·6	60·0	64·8	59·5	86	9·26	26	104·05
July	68·6	59·7	64·2	58·3	86	9·32	25	117·11
August	71·9	59·0	65·5	57·6	84	8·76	28	122·52
September	70·5	58·9	64·7	56·9	81	5·14	17	147·34
October	70·9	59·3	65·1	58·2	84	10·57	30	109·17
November	70·2	57·8	64·0	56·5	84	8·82	26	118·32
December	73·1	55·3	64·2	50·8	70	2·16	11	203·54
Annual	72·1	57·4	64·8	54 3	78	81·86	22·6	1982·09
			Means				Totals	

THE TEA RESEARCH INSTITUTE OF CEYLON.

BALANCE SHEET AS AT 31ST DECEMBER, 1932.

LIABILITIES.			ASSETS.		
GOVERNMENT OF CEYLON :—	Rs. Cts.	Rs. Cts.	PROPERTY :—	Rs. Cts.	Rs. Cts.
Loan at 6% per annum secured by mortgage Rs. 1,000,000·00			As at 31st December, 1931	725,198·38	
Less Repayments to date ,, 79,735·32	920,264·68		Expenditure 1932	16,139·74	741,338·12
Add Accrued Interest	13,803·97	934,068·65	BUILDINGS AND LINES :—	...	
RESERVE FOR SUPERINTENDENT'S FURLOUGH PAY AND PASSAGE ...	...	7,335·00	As at 31st December, 1931 after deduction of depreciation for 1930 and 1931.	698,338·45	
RESERVE FOR SENIOR SCIENTIFIC STAFF'S PASSAGES ...	...	4,543·26	Additions during 1932	62,844·30	
SUNDRY CREDITORS (Since paid) ...	...	3,038·62		761,182·75	
SUPERINTENDENT'S ACCOUNT ST. COOMBS	...	1,760·34	*Less* Depreciation for 1932 @ 5%	40,559·54	720,623·21
SURPLUS ACCOUNT :—			FURNITURE, EQUIPMENT ETC. :—		
At 31st December, 1931	653,236·58		As at 31st December, 1931 after deduction of depreciation for 1930 and 1931.	45,728·65	
Excess of Income over Revenue Expenditure 1932.	74,310·38	727,546·96	Additions during 1932	9,829·27	
				55,557·92	
			Less Depreciation for 1932 @ 10%	6,001·27	49,556·65
			MACHINERY AND TOOLS :—		
			As at 31st December, 1931 after deduction of depreciation for 1930 and 1931.	80,392·58	
			Additions during 1932	100·98	
				80,493·56	
			Less Depreciation for 1932 @ 10%	10,050·49	70,443·07
Carried forward :—		Rs. 1,678,292·83	Carried forward :—		Rs. 1,581,961·05

THE TEA RESEARCH INSTITUTE OF CEYLON.

BALANCE SHEET AS AT 31ST DECEMBER, 1932.

LIABILITIES	Rs. Cts.	ASSETS	Rs. Cts.	Rs. Cts.
Brought forward	1,678,292·83	Brought forward		1,581,961·05
		EXPERIMENTAL MACHINERY :—		
		As at 31st December, 1931 after deduction of depreciation for 1930 and 1931.	7,329·41	
		Additions during 1932	5,189·55	
			12,518·96	
		Less Depreciation for 1932 @ 10%	1,333·33	11,185·63
		MOTOR CAR :—		
		As at 31st December, 1931	5,300·30	
		Less Depreciation to date @ 25%	2,650·14	2,650·16
		CEYLON ASSOCIATION IN LONDON £22.14.5 @ 1/6		302·95
		JEREMIAH LYON & Co., £5.6.2 @ 1/6		70·79
		STOCK-IN-TRADE (Since sold)		8,897·39
		ACCRUED INTEREST TO 31ST DECEMBER, 1932.		114·89
		SUNDRY DEBTORS :—		
		Research Staff, since recovered	1,553·35	
		Controller of Finance and Supply (December Tea Cess since recd.)	21,894·46	
		Empire Marketing Board	1,247,·26	
		Amount due on Advertising Space	708·50	25,403·57
		CASH AT BANK :—		
		On Fixed Deposit	31,681·09	
		On Current Account	16,025·31	47,706·40
	Rs. 1,678,292·83			Rs. 1,678,292·83

A. W. L. TURNER,
Secretary.

We have audited the books of the Institute kept by the Planters' Association at Kandy in which are incorporated the Estate returns. We have not audited the Estate Accounts.

The allocations of Capital Expenditure, and of Research Revenue Expenditure as made by the Director and sanctioned by the Chairman have been accepted by us.

Subject to the foregoing, we certify that in our opinion the above Balance Sheet is a full and fair statement properly drawn up so as to exhibit a true and correct view of the state of the Institute's affairs according to the information and explanations afforded to us, and as shown by the books of the Institute kept at Kandy.

THE TEA RESEARCH INSTITUTE OF CEYLON.

ESTATE WORKING ACCOUNT TO 31ST DECEMBER, 1932.

EXPENDITURE			INCOME		
	Rs. Cts.				Rs. Cts.
To Estate Rev. Exp. per Statement	Rs. 70,935·69		By Tea Sales	126,625 lbs.	
,, Charges, Rail Freight Etc.	,, 4,914·65	75,850·34	,, do Inferior	2,918 lbs.	85,273·20
,, Balance C/down		9,422·86			
		Rs. 85,273·20			Rs. 85,273·20

INCOME AND EXPENDITURE STATEMENT AS AT 31ST DECEMBER, 1932.

	Rs. Cts.		Rs. Cts.
To Research Rev. Exp. per Statement ...	179,353·99	By Balance from Estate Working Account	9,422·86
,, Grant to Mycological & Entomological Insts.	1,500·00	,, Tea Cess	354,543·58
,, Govt. of Ceylon Loan Interest Account	56,192·77	,, Rent of Caddy ...	75·00
,, Depreciation	59,269·70	,, Interest	1,395·85
,, Balance (to Balance Sheet)	74,310·38	,, Grant from Empire Marketing Board ...	5,189·55
	Rs. 370,626·84		Rs. 370,626·84

LOAN ACCOUNT.

				Rs. Cts.	Rs. Cts.
To Government of Ceylon	Rs. 1,000,000·00	By Repayments	1st Instalment	1929	18,227·00	
		,, do	2nd	1930	19,320·72	
		,, do	3rd	1931	20,479·00	
		,, do	4th	1932	21,708·60	79,735·32
		,, Balance				920,264·68
	Rs. 1,000,000·00					Rs. 1,000,000·00

A. W. L. TURNER,
Secretary.

St Coombs Estate Tea Sales 1932